

Corn Silk

#93

4/2/74

CORN SILK

#93

Детальное изучение этого заболевания безусловно поможет выявить и этиологию мочекаменной болезни.

В настоящее время лечение мочекаменной болезни сводится либо к оперативному вмешательству на органах мочевой системы, направленному или к удалению камней или даже всей пораженной почки, либо же к применению консервативных методов лечения, временно облегчающих состояние больного.

В народной медицине для лечения мочекаменной болезни с положительными результатами издавна применяются настои различных трав, и особенно часто при этом используется настой волосков кукурузы.

Экспериментальными работами советских ученых подтверждены лечебные свойства препаратов волосков кукурузы как желчегонного средства. При применении настоев волосков кукурузы увеличивается секреция желчи, уменьшается ее плотный остаток, понижается ее вязкость, удельный вес и содержание билирубина.

По данным Р. К. Алеева, волоски кукурузы в своем составе содержат сахаристые, жировые и смолистые вещества, эфирные масла, хлорофилл, а также витамины С и К. Наличием последнего Р. К. Алеев и объясняет ускоренную свертываемость крови у собак при внутривенном введении им экстрактов из волосков кукурузы.

С лечебной целью при заболеваниях мочевых органов настоем волосков кукурузы, повидному, впервые был применен в клинике проф. Кордического в г. Кракове в 1885 г. с весьма положительными результатами, о чем свидетельствуют указания Барташевич. Этот настой, примененный при почечных камнях и подостром катаре мочевого пузыря и почечных лоханок, не только увеличивал количество выделяемой мочи, но также и уменьшал и катаральные явления в лоханках, оказывая болеутоляющее действие. Стувер (1887) в течение 5 лет многократно убеждался в способности вытяжек волосков кукурузы успокаивать боли в почках и мочевом пузыре. А. П. Цулукидзе (1937) указывает, что он в течение 10 лет для борьбы с инфекцией мочевых путей среди других средств пользуется настоем волосков кукурузы как «хорошим, не раздражающим почки диуретическим средством».

Кроме указанных авторов, применявших настой волосков кукурузы при заболеваниях мочевых путей, и, в частности, при мочекаменной болезни, мы в известной нам литературе более подробных данных о действии этого средства не нашли.

В немногочисленных литературных источниках указывается только факт широкого использования волосков кукурузы в народной медицине. Подробных же данных об изучении этого эмпирически применяемого средства, о его целебном действии, о показаниях и противопоказаниях к его применению, мы пока еще не имеем. Мочекаменная болезнь довольно распространена, и всякое средство, которое принесет облегчение больным этой болезнью, должно быть введено в практику. Исходя из этой предпосылки нами было проверено действие настоя волосков кукурузы на почечные камни различного состава, взятые у больных людей, и на патогенные бактерии в условиях пробирки *in vitro*. В опытах на различных животных проверялась безвредность препарата.

Настоем волосков кукурузы изготовлялся следующим образом: навески сухих волосков в 3, 5, 10 и 20 г помещались в колбы и заливались 100 мл дистиллированной воды, после чего колбы, закрытые ватными пробками, подвергались автоклавированию при давлении 0,5 атмосферы в течение 30 минут.

Приготовленный таким образом настой пропускался через фильтровальную бумагу и стерильно разливался по пробиркам, в которые затем

были помещены предварительно простерилизованные почечные камни определенного веса и различного химического состава, состоящие из оксалатов, фосфатов, карбонатов и уратов.

Одна часть пробирок помещалась в термостат при температуре 37° , а другая — оставлялась при обычной комнатной температуре. Наблюдение за состоянием камней продолжалось в течение 20 — 50 дней, причем настоей волосков кукурузы через каждые 3 — 4 дня менялся.

В ряде случаев почечные камни помещались в смесь мочи человека и настоя волосков кукурузы, но это не отражалось на результатах опытов.

В результате опытов наблюдалось или постепенное растворение камней (если они состояли из карбонатов) или разрушение их с образованием песка (если они имели в своем составе ураты и фосфаты). На камни, состоящие из оксалатов, настоей волосков кукурузы заметного действия не оказывал. Было установлено, что процесс растворения и разрушения камней почек идет быстрее, более интенсивнее при температуре 37° , чем при обычной комнатной (таблицы 1, 2, 3, 4).

Далее были проведены опыты по установлению бактериостатического и бактерицидного действия этого настоя на следующие патогенные бактерии: *Staphylococcus albus*, *Streptococcus*, *Bact. coli commune*, *Bact. dysenteriae Flexner*, *Bact. typhi abdominalis*, *Bact. dysenteriae shiga*, *Brucella abortus bovis*, *Brucella suis*, *Bact. anthracis*.

В результате оказалось, что настой волосков кукурузы в концентрациях 3 — 5 — 10 — 20% не обладают ни бактериостатическим, ни бактерицидным действием на указанные патогенные бактерии.

Токсичность же препаратов из волосков кукурузы изучалась на лягушках.

Изучение показало, что явления, наблюдаемые при общем действии настоя, представляют большое разнообразие в зависимости как от индивидуальности животного, так и от концентрации настоя и его дозы. Лягушкам вводилось подкожно в брюшной лимфатический мешок от 1 до 9 мл 10 и 20% настоя волосков кукурузы.

Каждая доза испытывалась сначала на одной лягушке, а затем на трех-четырех животных, примерно одинакового веса (45 — 50 г). Так, в серии 1 (10 лягушек) средний вес каждой лягушки был 45 г, в серии 2 (18 лягушек) — 50 г, в серии 3 (8 лягушек) животные весили по 50 г (таблицы 5, 6, 7).

Из приведенных данных видно, что лягушки, получившие 20% настоя волосков кукурузы в количестве 6 мл и больше, почти все погибли, а лягушки, получившие настоей в меньшей концентрации (10%), остались живыми, несмотря на то, что количество введенного им 10% и 20% настоя было одинаково.

Контрольные лягушки, получившие одинаковое количество (от 1 до 9 мл) 0,65% раствора хлористого натрия, все остались живы.

В зависимости от концентрации настоя лягушки вели себя по-разному. Например, после введения 10% настоя лягушки чувствовали себя лучше, чем те, которым был введен 20% настоя.

После введения настоя мы проверяли через час общее состояние животных. Координация движений у лягушек была сохранена, за исключением тех, которые получали по 7, 8, 9 мл настоя; у последних замечалась некоторая вялость в движениях. На внешние раздражения лягушки реагировали активно. Через 4 — 5 часов все лягушки чувствовали себя хорошо, за исключением тех, которые получали 7, 8, 9 мл 20% настоя; у последних наблюдалась постепенное угнетение и вялость, но при раздражении они делали координированный прыжок, через 8 — 10

Данные опыта № 1 по изучению разрушаемости почечных камней под влиянием 3% настоя волосков кукурузы (11. II — 1949 г.)

Table 1

Таблица 1

№ п/п	Type of kidney stones Сорт почечных камней и № пробирки and test tube no.	Temperature Температура при опыте during test	Первонач. вес камня I. II	Вес 14. II	Вес 18. II	Вес 22. II	Вес 26. II	Вес 29. II	Вес 1. III March	Вес 3. III	Результаты опыта Test results
1	Фосфатный—пробирка № 1 Phosphate - test tube no. 1	Комнатная Room temp.	1950	1935	1715	1310	950	65	15		a) Разрушение неполное, изменение идет медленно
2	Фосфатный—пробирка № 2 test tube no. 2	Т-ра термостата Thermostat temp.	1050	710	300	125	85				b) Полное разрушение, камень в виде мелкого песка
3	Уратный—пробирка № 1 Urate - test tube no. 1	Комнатная Room temp.	700	690	585	510	420	210	135		c) Неполное разрушение, камень в виде мелкого песка
4	Уратный—пробирка № 2 test tube no. 2	Т-ра термостата Thermostat temp.	500	375	210	105	75				d) Полное разрушение, камень в виде мелкого песка
5	Оксалатный—пробирка № 1 Oxalate - test tube no. 1	Комнатная Room temp.	3055	} No changes Без изменений							e) Уменьшение объема камня, осадка нет
6	Оксалатный—пробирка № 2 test tube no. 2	Т-ра термостата Thermostat temp.	2000								
7	Карбонатный—пробирка № 1 Carbonate - test tube no. 1	Комнатная Room temp.	2300	2015	1755	1360	985	715	310	175	e) Уменьшение объема камня, осадка нет
8	Карбонатный—пробирка № 2 test tube no. 2	Т-ра термостата Thermostat temp.	1750	1010	520	215	125	20			f) Растворение полное, осадка нет, настой прозрачный

Remarks.

Примечание. Номера пробирок даны условно. Все пробирки под № 1 находились в опыте в условиях комнатной температуры (16—18°), пробирки № 2—в термостате при температуре 35—37°. Вес камней во всех таблицах дан в миллиграммах.

Данные опыта № 2 по изучению разрушаемости почечных камней под влиянием 5% настоя волосков кукурузы (17.III—1949 г.)

Table 2
Таблица 2

№	Type of kidney stones Сорт почечных камней и № пробирки and test tube no.	Температура при опыте: ком- натная 10—16° термостата — 36—37°	Первичный вес камня 17. III	Вес 20. III	Вес 23. III March	Weight 27. III	Вес 2. IV	Вес 5. IV April	Вес 8. IV	Вес 12. IV	Test results Результаты опыта
1	Phosphate - test tube no. 1 Фосфатный — пробирка № 1	Комнатная Room temp.	520	505	410	385	300	265	210	115	a) Разрушение, камень в виде мелкого песка
2	Phosphate - test tube no. 2 Фосфатный — пробирка № 2	Thermostat temp. Т-ра термостата	400	310	205	180	125	75			b) Разрушение полностью, камень в виде мелкого песка
3	Carbonate - test tube no. 1 Карбонатный — пробирка № 1	Room temp. Комнатная	1300	1295	1270	1200	1160	1145	1125	190	c) Уменьшение объема, осадка нет
4	Carbonate - test tube no. 2 Карбонатный — пробирка № 2	Thermostat temp. Т-ра термостата	1215	1205	1170	1100	105	95	60		d) Резкое уменьшение объема, осадка нет
5	Urate - test tube no. 1 Уратный — пробирка № 1	Комнатная Room temp.	700	605	570	545	495	460	410	325	e) Уменьшение объема, в осадке песок
6	Urate - test tube no. 2 Уратный — пробирка № 2	Thermostat temp. Т-ра термостата	1000	705	548	490	310	250	63	110	f) Резкое изменение объема, в осадке песок.
7	Oxalate - test tube no. 1 Оксалатный — пробирка № 1	Комнатная Room temp.	2000	Без изменений No changes							
8	Oxalate - test tube no. 2 Оксалатный — пробирка № 2	Thermostat temp. Т-ра термостата	4500								

Примечание. В данных опытах камни почек помещались в смесь настоя волосков кукурузы и мочи, взятой от здорового субъекта.
Remarks. In these tests, the kidney stones were placed into a mixture of corn silk infusion and urine taken from a healthy subject.

Temperatures (10-16°C),
room temp (10-16°C),
thermostat temp (36-37°C)
stones on 15 mg.

Table 3
Таблица 3

Данные опыта № 3 по изучению разрушаемости почечных камней под влиянием 10% настоя волосков кукурузы (15.VIII—1949 г.)

№ п/п	Type of kidney stones Сорт почечных камней и № пробирки and test tube no.	Температура при опыте: комнатная 10-16° термостата 36-37°	Первичный вес камня 15/VIII	Вес 19/VIII	Вес 24/VIII	Вес 1/IX	Вес 5/IX	Weight 9/IX	Вес 14/IX	Вес 19/IX	Вес 24/IX	Вес 28/IX	Вес 2/X	Вес 6/X	Test results Результаты опыта
1	Phosphate - test tube no. 1 Фосфатный - пробирка № 1	Комнатная Room temp.	1030	1025	1015	1010	900	895	883	875	860	840	815	805	755
2	Phosphate - test tube no. 2 Фосфатный - пробирка № 2	Т-ра термостата Thermostat temp.	1050	1000	875	805	755	700	695	605	400	215	110	Полное разрушение	Complete destruction
3	Carbonate - test tube no. 1 Карбонатный - пробирка № 1	Комнатная Room temp.	610	3650	3310	1150	500	310	215	175	100	075	020		a) Камень растворился без осадка. Процесс растворения шел медленно
4	Carbonate - test tube no. 2 Карбонатный - пробирка № 2	Т-ра термостата Thermostat temp.	510	410	405	305	200	175	75	25	7	Быстрое растворение			
5	Urate - test tube no. 1 Уратный - пробирка № 1	Комнатная Room temp.	530	495	490	355	325	315	305	295	270	265	240	230	b) Медленное разрушение
6	Urate - test tube no. 2 Уратный - пробирка № 2	Т-ра термостата Thermostat temp.	500	405	310	205	110	90	85	60	Полное разрушение				c) Осадок в виде песка, процесс разрушения быстрый
7	Oxalate - test tube no. 1 Оксалатный - пробирка № 1	Комнатная Room temp.	4800												
8	Oxalate - test tube no. 2 Оксалатный - пробирка № 2	Т-ра термостата Thermostat temp.	2600												

Без изменений
No changes

Б. Д. ДЖАМАЛИЕВА

Данные опыта № 4 по изучению разрушаемости почечных камней
под влиянием 20% настоя волосков кукурузы (17.X—1949 г.)

Таблица 4
Table 4

Item # № п/п	Type of kidney stones Сорт почечных кам- ней и № пробирки and test tube no.	① Температура при опыте: комнатная 10—16°, термо- стата—36—37°	② Первичный вес камня 17(X) Oct.	Вес 27(X)	Вес 4(XI)	Вес 7(XI)	Вес 10(XI)	Вес 13(XI) Nov.	Вес 15/XI	Вес 18/XI	Test results Результаты опыта
1	Phosphate - test tube no. 1 Фосфатный—про- бирка № 1	Room temp. Комнатная	160	115	95	80	71	65	30	5	a) Частичное разрушение
2	Phosphate - test tube no. 2 Фосфатный—про- бирка № 2	T-ra термостата Thermostat temp.	510	325	181	102	88	52			b) Полное разрушение, камень в виде мелко- го песка
3	Carbonate - test tube no. 1 Карбонатный—про- бирка № 1	Комнатная Room temp.	130	115	100	93	67	46	44	32	c) Полное растворение, осадка нет, настой прозрачный
4	Carbonate - test tube no. 2 Карбонатный—про- бирка № 2	T-ra термостата Thermostat temp.	155	120	102	98	81	69	32		
5	Oxalate - test tube no. 1 Оксалатный—про- бирка № 1	Комнатная Room temp.	2210	Без изменений No changes..							
6	Oxalate - test tube no. 2 Оксалатный—про- бирка № 2	T-ra термостата Thermostat temp.	4550								

Table 5
Таблица 5

Dose of 10% corn
silk infusion injected
into each frog (in ml.) →

Доза введенного каждой лягушке 10% настоя волосков кукурузы (в мл)	Number of test frogs Количество лягушек в опыте	Результат опыта Results of test
4	2	Животные — Animals alive живы
5	2	
6	2	
7	2	
8	2	

Table 6
Таблица 6

Dose of 20% corn silk
infusion injected into
each frog (in ml.) →

Доза введенного каждой лягушке 20% настоя волосков кукурузы (в мл)	Number of test frogs Количество лягушек в опыте	Результат опыта Results of test
5	3	Животные живы — Animals alive 3 — погибли, ← died 1 — живо ← alive 2 — погибли, ← died 3 — живы ← alive Животные по- Animals died гибли
6	4	
7	5	
8	4	
9	2	

Table 7
Таблица 7

Dose of 0.65% NaCl
solution injected into
each frog (in ml.) →

Доза введенного каждой лягушке 0.65% раствора хлорида натрия (в мл)	Number of test frogs Количество лягушек в опыте (контроль) (control)	Результат опыта Results of test
5	1	Животные — Animals alive живы
6	1	
7	2	
8	3	
9	1	

часов лягушки утрачивали способность как к координации движений, так и к прыжкам. Приблизительно через 6—7 часов после введения 20% настоя в количествах 7, 8, 9 мл движения лягушек становились все более и более вялыми, вместо прыжков они лишь медленно передвигались и, наконец, становились совершенно неподвижными, дыхание прекращалось, рефлексы угасали. — disappeared, vanished

Приводим данные из протокола опытов 1 серии. Лягушке, весом 45 г, введено в брюшной лимфатический мешок 7 мл 20% настоя волосков кукурузы. Через 2 часа у лягушки появилась вялость. Через 5 часов при внешнем раздражении она медленно и с трудом передвигается. На другой день в 10 часов утра лягушка была найдена мертвой. Вес трупа — 52 г. При внешнем его осмотре особых изменений не обнаружено.

femoral

При вскрытии бедренных лимфатических мешков у лягушки было найдено с обеих сторон значительное количество светлой, прозрачной жидкости. В брюшном лимфатическом мешке также обнаружено боль-

шое количество слегка окрашенной в желтоватый цвет лимфатической жидкости. В полости живота — та же картина.

Сердце — в диастоле, с сильно расширенными предсердиями. На механическое раздражение желудочек сердца не отвечает. Печень уменьшена, серозеленого цвета, консистенция ее плотнее, чем в норме. Желудок ее гиперемирован. Полость желудка без особых изменений. Легкие в норме.

Лягушка № 2, весом 45 г. В 14 часов дня ей в брюшной лимфатический мешок введено 8 мл 20% настоя волосков кукурузы. Через 30 минут после введения лягушка стала более вялой. В 16 часов появилась небольшая отечность век. На внешние раздражения лягушка отвечает вяло. В 19 часов дыхание стало очень редким. На внешние раздражения лягушка не отвечает. В 20 часов лягушка погибла. Вес трупа — 60 г. При вскрытии в области бедренных лимфатических мешков слева и справа много жидкости, причем слева жидкости больше. На передней стенке мышц живота изменений нет. Имется очень слабая гиперемия кожи живота.

В брюшном лимфатическом мешке — небольшое количество свободной жидкости. В полости живота много прозрачной жидкости.

Сердце остановилось в диастоле, переполненное кровью. При механическом раздражении сердце дважды слабо сократилось. Печень небольших размеров, серозеленого цвета. Желудок и брыжейка слегка гиперемированы, более чем в норме.

Желудок без особых изменений. Мочевой пузырь в норме.

Лягушка № 1, весом 50 г. Введено через правый бедренный мешок в брюшной лимфатический мешок 6 мл 20% настоя волосков кукурузы. Через 2 часа после введения лягушка стала более вялой, но на внешнее раздражение отвечает активно. Координация движений сохранена. Через 6 часов изменений не произошло. Через сутки лягушка выглядит бодро. Отеков век не наблюдалось. При внешнем осмотре лягушки патологических изменений не обнаружено.

Через 2 суток вес лягушки увеличился до 60 г. Появилась незначительная отечность век. Вялость усиливается. Движения стали пассивными, но при внешнем раздражении лягушка делает прыжок. Отечность век стала значительно больше. На 3 день после введения настоя в 9 часов утра лягушка найдена мертвой.

При наружном осмотре лягушки обнаружено, что кожа в области живота резко гиперемирована.

В правом бедренном мешке — некоторое количество прозрачной жидкости. Кожа бедра с внутренней стороны гиперемирована больше на левом бедре. Консистенция мышц правого бедра более мягкая, чем в норме.

В полости живота — прозрачная жидкость. Предсердия переполнены кровью. Желудочек сердца несколько сокращен. Желудок пуст и содержит немного слизи. Мочевой пузырь переполнен. В остальных органах особых изменений не обнаружено.

И. И. Синерцев провел испытание токсичности настоя волосков кукурузы. Препарат представляет собой прозрачную красновато-бурую жидкость. Испытание препарата было проведено на лягушках, морских свинках, кроликах и собаках.

Лягушкам, весом в 58, 65 и 61 г, было введено в брюшной лимфатический мешок: первой 5 мл, второй 6 мл и третьей 10 мл 10% настоя волосков кукурузы. На другой день лягушки найдены очень вялыми, отеками, особенно отеки нижние веки. При взвешивании оказа-

лось, что лягушки значительно прибавили вес, сверх веса введенного им настоя. Так, лягушка № 1 (получившая 5 мл настоя) прибавила в весе 17 г, лягушка № 2 (получившая 6 мл) — 19 г, лягушка № 3 (получившая 10 мл) — 23 г. Лягушки содержались в полулитровых стеклянных банках, в которые было налито небольшое количество водопроводной воды, и вес их, повидимому, увеличился за счет всасывания через кожу воды, другой какой-либо жидкости лягушки не получали.

В последующие дни лягушки оставались очень вялыми, но их вес все более и более снижался. Через неделю после введения настоя вялость их стала уменьшаться, и вес почти возвратился к исходному к 12 дню после введения настоя. Все три лягушки остались живы.

Дальнейшая серия опытов по испытанию токсичности настоя была проведена на пяти морских свинках, весом от 360 до 435 г, из которых одна свинка (№ 3) была контрольной, препарат ей не вводился. Четверем остальным свинкам 20% настоем волосков кукурузы вводился подкожно в область правого бедра: свинке № 1 — 8 мл, свинке № 2 — 9 мл, свинке № 4 — 7 мл и свинке № 5 — 10 мл. Каких-либо отклонений от нормы в поведении морских свинок, а также инфильтрат на месте введения настоя (через три дня после введения) обнаружить не удалось. Но вес двух подопытных свинок незначительно (на 10 — 20 г) уменьшился, одновременно уменьшился и вес контрольной свинки; вес же двух остальных свинок увеличился, но незначительно — на 15 — 25 г. Через четыре дня после первого введения тем же четверем свинкам настоем был введен вторично, но в область левого бедра: свинке № 1 — 11,5 мл, № 2 — 12,5 мл, № 4 — 12,5 мл и № 5 — 12,5 мл.

На другой день после введения у трех свинок на месте введения отмечен инфильтрат, у свинки № 1 инфильтрат найден не был. Через три дня после введения настоя инфильтрат на месте введения ни у одной из свинок уже не обнаруживался, он полностью рассосался. Каких-либо отклонений после второго введения настоя в поведении свинок не было замечено. На другой день после введения настоя вес подопытных свинок уменьшился на 30 — 40 г (у контрольной он оказался повышенным на 5 г), но в дальнейшие дни вес их стал повышаться и через 12 дней у свинок № 2 и 4 даже превышал на 50 г исходный (т. е. вес до первого введения им настоя), а у № 1 и 5 и у контрольной вес возвратился к исходному состоянию. Через 12 дней после первого введения дальнейшие наблюдения над свинками были прекращены.

В дальнейшем были взяты четыре собаки: № 1 — вес 10,05 кг, № 2 — 15,6 кг, № 3 — 8,15 кг и № 4 — 7,15 кг. Собаке № 1 было введено 21 мл настоя волосков кукурузы, собаке № 2 — 15,6 мл. Собака № 1 через 2 часа после введения настоя стала слегка прихрамывать на левую ногу, но на другой день это явление у нее исчезло. Других каких-либо изменений в поведении собаки обнаружить не удалось. Через 5 дней после первого введения тем же двум собакам был подкожно в область правого бедра вторично введен пятипроцентный настой: собаке № 1 — 43 мл (по 4 мл на 1 кг ее живого веса), а собаке № 2 — 40 мл (по 2,6 мл на 1 кг веса). На этот раз каких-либо изменений в поведении собак отметить также не удалось. Вес у собаки № 1 через 10 дней после введения повысился на 700 г, а у собаки № 2 уменьшился на 300 г.

Двум другим собакам настоем волосков кукурузы был введен в желудок через рот при помощи зонда. Собака № 3 получила 163 мл 10% настоя (по 20 мл на 1 кг ее живого веса), а собака № 4 — 320 мл (150 мл 10% и 170 мл 5% — по 44 мл на 1 кг веса). Нарушений в поведении собак не отмечалось. Через 5 суток после первого введения собака № 3 получила 504 мл 5% настоя (по 60 мл на 1 кг веса), а

собака № 4 — 470 мл 5% (по 65 мл на 1 кг веса). Их поведение не изменилось. Вес у них через 10 дней после первого введения настоя повысился: у собаки № 3 с 8,15 кг до 9 кг, а у собаки № 4 с 7,15 до 7,2 кг.

Последняя серия опытов была проведена на 5 кроликах с внутривенным введением им 20% стерильного настоя волосков кукурузы. Кролику № 1 (вес 1,7 кг) в вену уха было введено 9 мл 20% настоя, кролику № 2 (вес 1,64 кг) — 14 мл, кролику № 3 (вес 1,97 кг) — 10 мл, кролику № 4 (вес 1,75 кг) — 10 мл и кролику № 5 (вес 1,61 кг) — 10 мл. Живой вес всех кроликов через четыре дня после введения настоя уменьшился с 50 до 135 грамм, других изменений отметить не удалось. Через четыре дня после первого введения тем же кроликам было вторично внутривенно введено: кролику № 1 — 9,5 мл настоя, кролику № 2 — 7 мл, кролику № 3 — внутривенно 3 мл и подкожно (в область левого бедра) 10 мл, кролику № 4 — 5 мл внутривенно и 4 мл подкожно и кролику № 5 — внутривенно 9 мл.

Каких-либо изменений в поведении кроликов не наблюдалось, тотчас же после введения препарата кролики стали есть свеклу. Следует только отметить, что через три дня после второго введения настоя (т. е. через семь дней после первого введения) вес кроликов уменьшился: у кролика № 1 — с 1,71 кг до 1,55 кг, у кролика № 2 — с 1,64 кг до 1,43 кг, у кролика № 3 — с 1,97 кг до 1,77 кг, у кролика № 4 — с 1,75 кг до 1,475 кг и у кролика № 5 — с 1,61 кг до 1,545 кг, т. е. падение веса происходило в градации в среднем от 65 г до 275 г на каждое животное.

Таким образом, при испытании 5 — 20% настоя волосков кукурузы в названных количествах он оказался практически не токсичным для морских свинок (при подкожном введении), для собак (при подкожном введении и введении через рот в желудок) и для кроликов (при внутривенном введении).

Полученные данные послужили основанием к проведению более углубленных экспериментов для изучения лечебных свойств настоя волосков кукурузы, результаты которых будут нами публиковаться по мере накопления материала.

Все вышеуказанные опыты проводились лабораторией кафедры фармакологии в Казахском медицинском институте им. В. М. Молотова под руководством проф. И. И. Сиверцева.

Выводы

1. При воздействии 3, 5, 10 и 20% настоя волосков кукурузы на почечные камни, взятые у больных людей при операциях, наблюдались растворение камней (состоящих из карбонатов) и разрушение с образованием песка (состоящих из уратов и фосфатов). На почечные камни, состоящие из оксалатов, настоек волосков кукурузы растворяющего и разрушающего действия не оказывал.

2. Разрушение и растворение почечных камней под влиянием настоев волосков кукурузы шло быстрее при определенной температуре. Особенно эффективной оказалась температура в 37°.

3. Настой волосков кукурузы в наших опытах не оказывал бактериостатического и бактериоцидного действия в отношении ряда патогенных бактерий.

4. Настой волосков кукурузы (5, 10, 20%) при введении морским свинкам подкожно (в дозах от 7 — 12 мл), кроликам внутривенно (в дозах от 3 — 10 мл), собакам подкожно (в дозах от 40 — 45 мл), собакам

в желудок, через рот (в дозах от 163 — 320 мл), лягушкам при введении в лимфатический мешок (в дозах от 5 мл) не оказал токсического действия. Лягушки погибали только при введении им 6 — 9 мл 20% настоя.

Заключение

Как известно, препараты волосков кукурузы применяются в клинической практике в качестве желчегонного средства. На основании наших опытов можно рекомендовать настой волосков кукурузы в клинических условиях и для лечения больных мочекаменной болезнью. Однако мы не рекомендуем лицам, страдающим одновременно с мочекаменной болезнью также и гипертонической болезнью, и пожилым людям назначать более крепкие настои, чем 3%, так как в наших опытах 5% настой волосков кукурузы при внутривенном введении повышал кровяное давление собак.

ЛИТЕРАТУРА

- Алиев Р. К. Материалы к характеристике химического состава и кровосвертывающего действия стигмата манса. Баку, 1947. Симонова В. И. Роль в этиологии мочевых камней. Ташкент, 1947. Стувер. Из текущей прессы. Врач № 2, 1887, том VIII, стр. 30. Барташевич. Из текущей прессы. Врач № 1, 1885, том VI, стр. 12, § 7. Геблер К. Физико-химические проблемы в хирургии. 1935. Землинский С. Е. Лекарственные растения СССР. Москва, 1949. Михлин Д. М. Регуляция свертывания крови и витамин К₃. Советская медицина № 5 — 6, Москва, 1943. Еланский Н. Н. Новые пути в этиологии и терапии нефролитиаза. 1940. Чулукидзе А. П. Пути профилактики и лечения почечнокаменных болезней. Урология, том XIV, № 2, Биомедгиз, 1937. Шмуклер Б. А. Фосфатурия (мочекаменный диатез). Ленинград, 1941.

urolithiasis

diathesis

РЕЗЮМЕ

Осы стигмата манс тұндырмасының бүйрек тасына әсерін алдынала байқау жұмысын Қазақстанның Ғылым академиясының Микробиология секторының лабораториясында 1949 жылы жүргіздік. Және жүгері үкісінің тұндырмасының ауру бактериясына әсері зерттелді. 1950 — 51 жылдары стигмата манс үкісінің тұндырмасының әртүрлі хайуандарға зиянсыздығы тексерілді.

1. Концентрациясы 3 — 5 — 10 — 20 процент стигмата манс тұндырмасының әсері арқасында, карбонаттардан тұратын тастардың ақырындап еритіні және олардың бұзылуының нәтижесінде, ураттар мен фосфаттардан тұратын құм пайда болатыны, лабораторияда жүргізілген тәжірибелердің қортындысының нәтижесінде анықталды. Стигмата манс тұндырмасы, оксалаттардан тұратын тастарға көрінетіндей әсер етпейді. Концентрацияны езген сайын стигмата тұндырмасының әсерінен, еру процесі және бүйрек тастарының бұзылуы тездетіледі. Бұл процесс комнаталық температурадан жоғары 37°-та өте тездетіледі.

2. Стигмата манс тұндырмасының бактерияларды өлтіруге және оларды әлсіретуге әсері жоқ.

3. Стигмата манс тұндырмасының әртүрлі хайуандарға зиянсыздығы тексерілді. Осының нәтижесінде, стигмата манс тұндырмасын теңіз шошқасының, терісінің астына иттің терісінің астына жібергенде және ас қазанына құйғанда, үй қоянының тамырына құйғанда және көлбақаның бауырындағы терісінің астына құйғанда, оның ұландырмайтыны анықталды.

Сондықтан біздің жүргізілген жұмысымыздың нәтижесінде стигмата маис тұндырмасының хайуандарға зиянсыздығы және карбонаттардан, фосфаттардан, ураттардан тұратын бүйрек тастарын ерітетіндігі, үгітетіндігі анықталды. Стилмата маис тұндырмасының ауру бактериясын өлтіруге және әлсіретуге әсер етпейтіні анықталды.

4. 3% тен жоғары жүгерінің тұндырмасын гипортониямен ауырған адамға беруге болмайды. Және жасы ортадан асқан адамдарға да беруге болмайды, себебі тамырдың ішіндегі күш көбейіп, тамыр жарылып кетуі мүмкін.

Food Protection Committee, Food and Nutrition Board

1965

Chemicals Used in Food Processing

National Academy of Sciences, National Research Council,
Washington, D.C. Publication 1274

Pages 96; 225

Food Protection Committee, 1972

Comprehensive GRAS Survey

National Academy of Sciences, National
Research Council, Washington, D.C.

6; 21; 114-115

Furia, T. E. and N. Bellanca

1971

Fenarolis Handbook of Flavor Ingredients

The Chemical Rubber Company
Cleveland, Ohio

Page 95

Drogenkunde--Handbuch der Pflanzlichen und
Tierischen Rohstoffe (Pharmacology--Manual
of Vegetable and Animal Raw Materials)
p. 962, 1958

Zea mays
Gramineae

By Heinz A. Hoppe

Origin: Native country, tropical America, cultivated in all warm countries. Principal cultivation regions are USA, Brazil, Argentina and other South American countries, Southern Europe, Central and South Asia, Africa.

Products used are 1. Corn silk; 2. Cornstarch; 3. Corn oil

1. Corn silk

Trade names: Stigmatidis, Stylidis (Latin); Stigmata Maidis (hom.); Maisgriffel, Maisnarben (German); Corn silk (Engl.); Stigmates de mais (French); Estigmas de maiz (Spanish); Estigmas de milhe (Port.)

Official Pharmacopeias: Erg. B 6, Ph. Franc., Ph. Helv., USP-Hom. A.B.
(fresh corn silk)

Components: about 2.25-3% saponins, brown dye, flavones, about 11.5-13% tannin (according to other data 3.55-4.15%), about 2.5% resin, about 0.1-0.2% essential oil with about 18% carvacrol, about 1.85-2.25% fatty oil with arachic and linoleic acids, pentosans, pentoses (1), up to 0.05% of a chemically not yet identified alkaloid, about 1% bitter product (glucoside).

Use: Diuretic, in urinary disorders and treatment of urinary gravel.

Antibesic agent, antidiabetic (the action is apparently uncertain (2) (3)).

In homeopathy, used in organic heart diseases accompanied by edema. Corn silk is used in Peru as a narcotic (alkaloid action).

HEINZ A. HOPPE

DROGENKUNDE

HANDBUCH
DER PFLANZLICHEN UND TIERISCHEN ROHSTOFFE

Manual of vegetable and animal raw materials
Manuel des matières premières végétales et animales
Manual das matérias primas vegetais e animais
Manual de materias primas, vegetales y animales

SIEBENTE VERÄNDERTE UND ERWEITERTE AUFLAGE



CRAM, DE GRUYTER & CO, HAMBURG, 1958

Zea mays

Gramineae

Herkunft: Heimat trop. Amerika, kultiviert in allen wärmeren Ländern. Hauptanbaugebiete sind USA, Brasilien, Argentinien und andere südamerikanische Länder, Südeuropa, Mittel- und Südasiens, Afrika.

Verwendet werden: 1. die Maisgriffel — 2. die Maisstärke — 3. das Maiskeimöl

1. die Maisgriffel

Handelsbezeichnungen: *Stigmata Maidis*, *Styli Maidis* (lat.) — *Stigmata Maydis* (hom.) — Maisgriffel, Maisnarben (deutsch) — Corn Silk (engl.) — *Stigmata de mais* (franz.) — *Estigmas de maíz* (span.) — *Estigmas de milho* (port.)

Offizinell: Erg.B. 6, Ph. Franç., Ph. Helv., USP, — Hom. A. B. (frische Maisnarben)

Inhaltsstoffe: ca. 2,25—3% Saponine, brauner Farbstoff, Flavone, ca. 11,5—13% Gerbstoff (nach anderen Angaben 3,55—4,15%), ca. 2,5% Harz, ca. 0,1—0,2% äther. Öl mit ca. 18% Carvacrol, ca. 1,85—2,25% fettes Öl mit Arachin- und Linolsäure, Pentosane, Pentosen¹⁾, bis 0,05% chem. noch nicht bekanntes Alkaloid, ca. 1% Bitterstoff (Glykosid).

Verwendung: Diureticum, bei Harnbeschwerden und Blasengriß. Entfettungsmittel. Antidiabeticum (die Wirkung ist offensichtlich unsicher)^{2) 3)}. In der Homöopathie bei organ. Herzleiden mit Ödemen. — Maisnarben werden in Peru als Rauschgift benutzt (Alkaloidwirkung).

962

2. die Maisstärke

Handelsbezeichnungen: *Amylum Maidis* (lat.) — Maisstärke (deutsch) — Corn Starch (engl.) — *Amidon de mais* (franz.)

Offizinell: DAB 6, Ph. Brit., Ph. Franç., Ph. Helv., USP, UdSSR.

Inhaltsstoffe: Maisstärke wird auf verschiedenen fabrikatorischen Wegen meist aus dem Pferdezaanmais gewonnen. Ausbeute ca. 65%. Die Handelsware enthält ca. 84% Stärke, ca. 0,5—1,5% Stickstoffsubstanzen, ca. 14% Wasser.

Verwendung: Zu Nährpräparaten, Pudern, Streupulvern, Bindemittel für Pillen und Tabletten. Maisstärke bewirkt einen sehr raschen Zerfall der Tabletten. — Technisch als Appreturmittel. Zur Herstellung von Glanzstärken. Aus Maisstärke werden Glukose, Maltose und Sirup gewonnen.

3. das Maiskeimöl

Handelsbezeichnungen: Maiskeimöl, Maisöl (deutsch) — Corn Oil (engl.) — Huile de mais (franz.)

Offizinell: USP

Inhaltsstoffe: Getrocknete Maiskeime enthalten ca. 30—50%⁴⁾ fettes Öl mit ca. 93% Glyceriden der Linol- und Ölsäure, ca. 7% festen Fettsäuren. — Schwach trocknendes Öl.

Verwendung: Zur Herstellung von Seifen, zur Bereitung von Faktis. — Raffiniertes Maisöl ist ein gutes Speiseöl. In der Margarinefabrikation. Gehärtetes Maisöl findet in der Speisefettindustrie Verwendung.

Aus dem Maisöl werden Fettsäuren gewonnen, die zur Herstellung von Kunstharzen, Tinten, Kitten, Metallseifen, flüssigen Seifen, Wachsen, Insektiziden und als Basis für arzneiliche und kosmetische Präparate Verwendung finden.

Aus dem Maisöl werden ferner höhere gesättigte und ungesättigte Fettalkohole, Fettalkoholsulfonate u. a. Alkoholderivate für verschiedene Verwendungszwecke erzeugt⁴⁾.

Bemerkungen: vgl. *Triticum* (Getreidekeimöle).

Von *Z. mays* sind ca. 300 Kulturvarietäten bekannt. Die wichtigsten sind: Gemeiner Mais — Perlmais mit kleinen, glänzenden Früchten — Pferdezaanmais mit großen flachen Früchten — Zuckermals mit runzeligen, glasigen Früchten, die nur wenig Stärke, aber reichlich wasserlösliche Kohlehydrate enthalten — Cuzcomais mit flachen, spitzen, bis 2,5 cm langen Früchten — Balgmais mit krautigen Hüllspelzen.

Der gelbe Farbstoff der Maiskörner ist Zeaxanthin ohne Vitamin A-Eigenschaften^{5) 6) 7) 8) 9) 10) 11)}.

Maiskörner enthalten ferner 2,5—10% Zein¹²⁾. Es wird industriell aus Gluten, einer Mischung von Pflanzeneiweiß, gewonnen. Verwendung in der Plastik-, Papier-, Druckfarben- und Filmindustrie.

Further Studies on the Responses of Corn Earworm¹ Larvae to Extracts of Corn Silks and Kernels^{2,3}

W. W. McMILLIAN, B. R. WISEMAN, AND A. A. SEKUL

Entomology Research Division, Agr. Res. Serv., USDA, Tifton, Georgia 31794

ABSTRACT

An intimate relationship was found between the larvae of *Heliothis zea* (Boddie) (Lepidoptera: Noctuidae) and certain components of the corn plant, *Zea mays* L. Presented data are interpreted as an explanation of why

the early instars of the corn earworm feed on corn silks, then penetrate to different kernel depths and feed in varying amounts depending on the synchronization of larval and plant development.

Painter (1951) divided plant resistance into 3 basic mechanisms: preference, antibiosis, and tolerance. Of these mechanisms, discriminate feeding is considered to be more closely associated with preference, though antibiosis may be involved. Tolerance has a lesser role in a study of this type of feeding, because the plant plays the predominant part and the insect-plant relationship is not so critical.

As early as 1935, Poole suggested that some chemical compound or compounds probably confer the resistance of corn, *Zea mays* L., to the corn earworm, *Heliothis zea* (Boddie). Then in 1965, Starks et al. reported a response by 4th-instar corn earworms to a water extract of corn silks and kernels. This bioactive material was characterized as a larval arrestant and feeding stimulant. In 1966 it was demonstrated (McMillian and Starks) that the response of 4th-instar corn earworms to a water extract of various primary and secondary plant hosts varied in degree. It was further demonstrated (McMillian et al. 1967, Starks and McMillian 1967) that highly significant differences in the response of 4th instars could be obtained from extracts of various corn lines, and that the response to the arrestant-feeding stimulant bioassayed in the laboratory was closely associated with the damage that occurred in the field in infested corn ears.

What then induces the larval corn earworm to feed on the corn plant? The question is sufficiently important to have produced the current intensive investigations into the relationships between insect behavior and plant extracts. Suppression of insect populations or reduction in damage by the development of resistant host plants might result from a study of this relationship.

The study reported here is a continuation of investigations being made at the Southern Grain Insects Research Laboratory at Tifton into the relationship between the feeding response of larvae of the corn earworm in various stadia to extracts of corn silks and kernels at various stages of development and the association of these laboratory feeding responses with damage done in the field. Emphasis was placed on the ability of larvae to discriminate between and among phagostimulative substances.

GENERAL METHODS

Ear shoots of 'Stowell's Evergreen' sweet corn hybrid contained in a 1-acre planting were capped with bags before the silk appeared, and the nonpollinated silks were harvested 3 days after emerging from the shoot tip. Other silks were hand pollinated 3 days after they appeared and were harvested 3, 6, 9, and 12 days later (Fig. 1).

A 2nd group of ear shoots was capped and hand pollinated 3 days after the silk emerged, and the corn kernels were harvested from these ears 5, 10, 15, 20, and 30 days later (Fig. 2). A field evaluation of earworm damage to artificially infested ears was also conducted in conjunction with the laboratory tests.

For the bioassays, the plant parts from each age group were processed separately as previously described (McMillian et al. 1967). Briefly, the technique of extracting the feeding stimulant was: (1) the plant material was blended 5 min in distilled water, (2) the liquid portion (containing the water-soluble feeding stimulant) was filtered and centrifuged 15 min at 2000 rpm, (3) the resultant supernatant was heated at 70°C for 1 min and filtered, (4) the filtrate was quick-frozen in a dry ice-acetone bath and lyophilized, and (5) the resulting dry residue was labeled "feeding stimulant extract." In addition, the feeding stimulant extracts from silks and kernels of certain selected ages were subdivided for some bioassays into 2 fractions each by exhaustive extraction with pyridine.

The series of bioassays reported here were made by using the feeding stimulant extracts or fractions of the extracts. Test earworm larvae selected by age as well as size of head capsule and body to represent each of the 6 instars were obtained from the laboratory colony (Fig. 3), which had been reared for at least 6 generations on an artificial diet (R. L. Burton, personal communication) called CSM (corn, soy, and milk). All larvae were starved for 3 hr prior to being placed on the extract-treated carrier.

Significant differences in larval feeding were distinguished either by Duncan's new multiple range test or by the method of paired comparisons. Square-root transformations were used throughout.

TESTS AND RESULTS

Bioassay 1.—Because previous evaluations of feeding stimulants had involved the responses of only late 3rd or early 4th instars to extracts of kernels ca. 10

¹ Lepidoptera: Noctuidae.

² Journal Series Paper no. 492, University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton. Received for publication May 29, 1969.

³ Mention of a proprietary product does not necessarily imply its endorsement by the USDA.

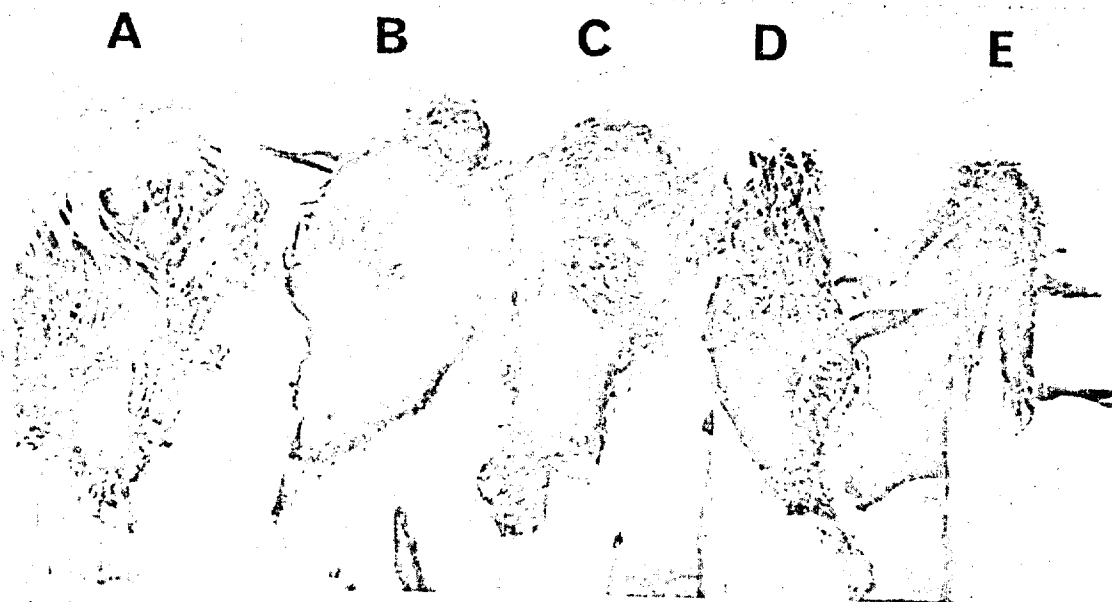


FIG. 1.—Silks of Stowell's Evergreen sweet corn before and after pollination. A, Nonpollinated; B, 3 days after pollination; C, 6 days after pollination; D, 9 days after pollination; E, 12 days after pollination.

days after the ears were pollinated, a bioassay was designed to monitor the responses of each of the 6 instars to extracts of silks and kernels obtained at a particular time after ear pollination. Procedure with 4th, 5th, and 6th instars was that described previously (McMillan et al. 1967); each extract was reconstituted in a ratio of 1 g of lyophilized residue/6 ml of distilled water. Extracts were pipetted onto sections of Whatman® no. 4 filter paper at a rate of 0.1 ml of

extract/paper. After they air dried, the treated papers were placed in each of 2 sections of a quadrant petri dish, and water-treated papers (check) were placed in the 2 remaining quadrants (Fig. 4).

The procedure for bioassaying the 1st, 2nd, and 3rd instars was modified, because the feeding responses of these small larvae were too difficult to monitor on the filter paper. Exploratory tests (Wiseman et al. 1969) had indicated that leaf sections of *Oxalis violacea* (L.) were an acceptable substitute and were, therefore, used for the carrier, because single bites by the 1st instars could be detected and measured with ease.

After the leaf sections were dipped in the extract or water check, they were air dried and placed in quadrant dishes that had filter paper covering the bottom (Fig. 4). In each bioassay, 10 dishes/replicate and 10 replications were used for each instar exposed to a particular extract.

The 2nd through the 6th instars were placed 1 larva/dish and the 1st instars were placed 5 larvae/dish during the testing period. They were allowed a free choice between the treated material and the check for 18 hr. During this time, they were left undisturbed in a darkened laboratory maintained at 24°C and 30% RH. Then the larvae were removed, and the areas of filter paper or leaf consumed were measured by using a grid divided into square millimeters. The feeding preference between each kernel extract or each silk extract and its water-treated check was determined for each instar by obtaining the average amount consumed per larva on both treatment and check.

The water extract of each sample of silks caused significant feeding (at the 5% level of confidence) by all instars (Table 1) as did the water extract of 5-day-old kernels. However, 10-, 15-, 20-, and 30-day-

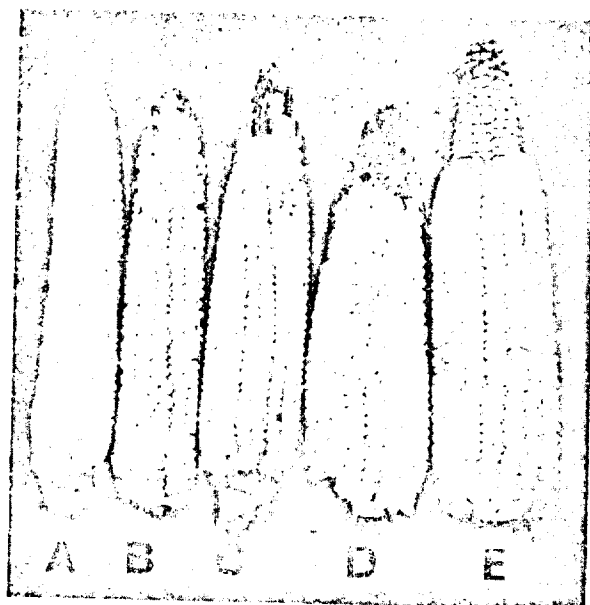


FIG. 2.—Stages of development of kernels on ears of Stowell's Evergreen sweet corn at several intervals (in days) after hand-pollination. A, 5; B, 10; C, 15; D, 20; E, 30.

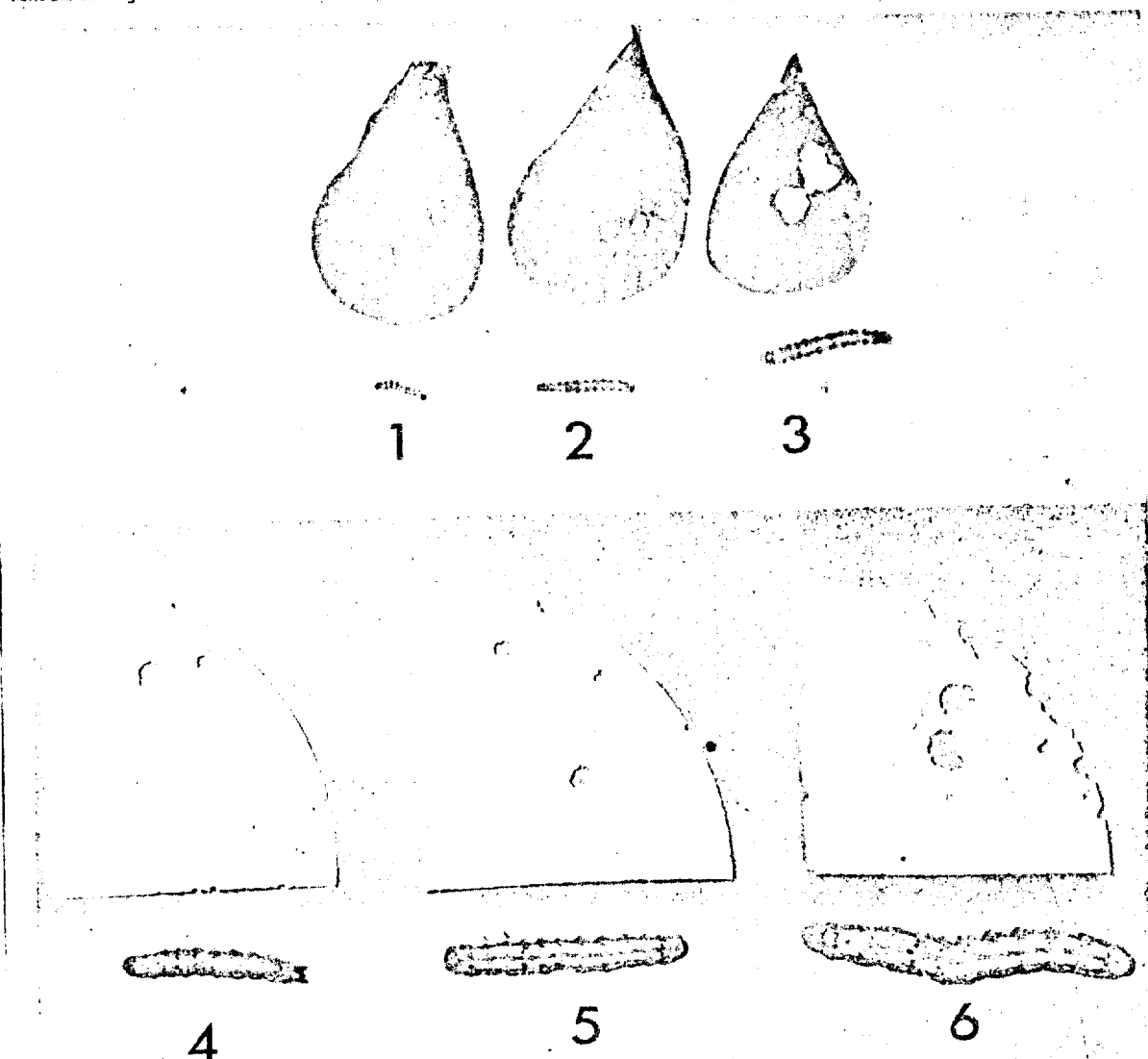


FIG. 3.—Illustrations to show relative sizes of 6 instars of corn earworm and relative area consumed by each instar.

old kernels did not cause a significant response by 1st instars, the 2nd instars did not respond significantly to extracts of 15-, 20-, and 30-day-old kernels, and the 3rd instars did not respond significantly to extracts of 15- and 30-day-old kernels. The overall reduced feeding by the 4th and later instars on filter paper carrier from that of the 3rd and earlier instars on leaf carrier in this and subsequent bioassays was the result of the change in the carrier. However, this overall reduced feeding on filter paper was not considered objectionable, since comparisons were not made between larvae feeding on the 2 different carriers.

Bioassay 2.—Once the extracts that caused a feeding response by the larvae were determined, the degree of response of a particular instar to the extract of silks or kernels of each of the 5 ages was studied. The techniques were as described in Bioassay 1. However, feeding preference was deter-

mined by measuring only the amount consumed per larva among extract treatments.

Preferences of instars among the extracts of silks were unclear (Table 2). However, 4th instars seemed to have some preference for younger silks. The preferences among extracts of kernels were more definite: 1st, 2nd, and 3rd instars preferred the extract of 5-day-old kernels; 4th instars showed no preference among extracts of 5-, 10-, 15-, and 20-day-old kernels but did prefer 15- and 20-day kernels over 30-day-old kernels; and 5th instars preferred extracts of 5-, 10-, and 15-day-old kernels. The 6th instars did not have significant feeding preferences among the kernel extracts bioassayed.

Generally, the extent of larval feeding in Bioassays 1 and 2 was in agreement.

Bioassay 3.—In the field the female adult earworm normally prefers to oviposit on fresh, emerging silks of corn ears (Phillips and Barber 1933). Three days

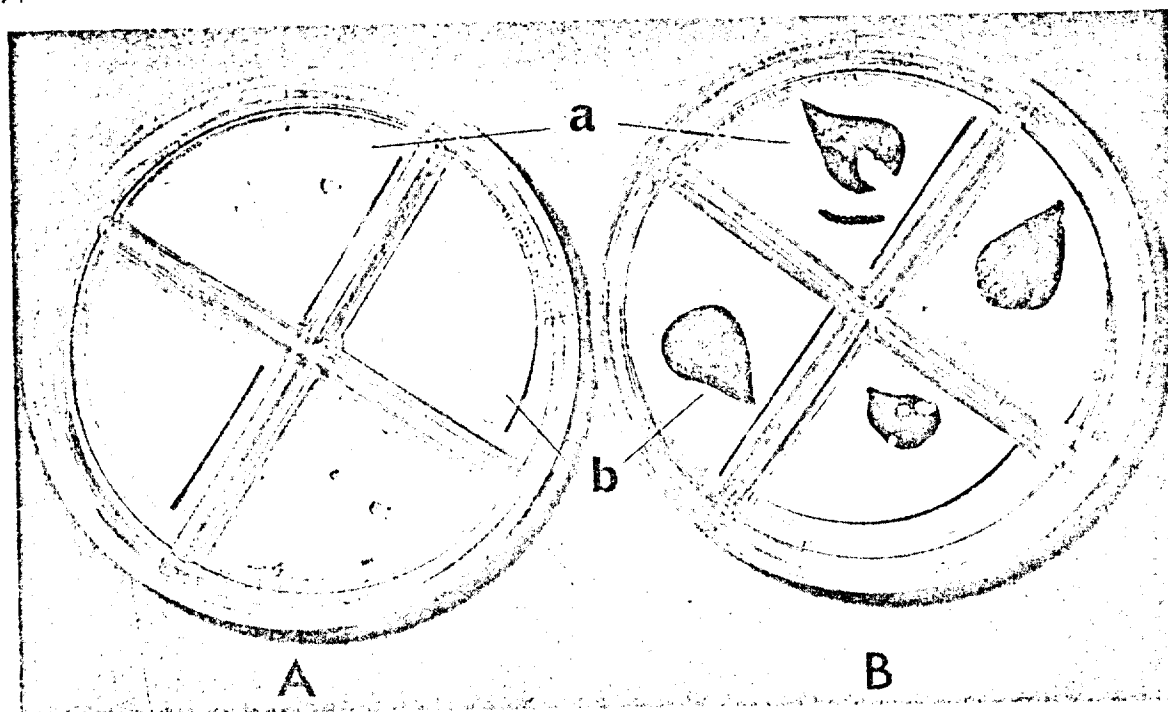


FIG. 4.—Typical dishes set up for bioassaying, showing responses to phagostimulative substances. A, Used for 4th, 5th, and 6th instars; B, used for 1st, 2nd, and 3rd instars. (Carriers extract-treated, a, and water-treated, b.)

after the silks emerge, they are most attractive to the moths. Barber (1944) found that newly hatched earworms fed in the silk mass for 8–10 days and usually reached the kernels by the time they were 4th or 5th instars. At the same time, the ear had grown considerably, and physiological changes were

taking place in the corn silks and kernels, largely because of ear pollination.

Therefore, the 3rd bioassay was designed to compare the feeding responses of larvae of all 6 instars when they were given a free choice between a water extract of nonpollinated silks or of 12-day-old polli-

Table 1.—Average areas (mm^2 of carrier) consumed per larva given a choice between carriers treated with extracts (Ex) of corn silks or kernels of several ages and a water-treated check (Ck).

Extracts from silks at indicated days after pollination										
Instar	0 ^a		3		6		9		12	
	Ex	Ck	Ex	Ck	Ex	Ck	Ex	Ck	Ex	Ck
1	1.0	0.7	1.2	0.5	1.3	0.5	1.0	0.4	1.2	0.4
2	3.5	.3	2.2	.2	2.1	.2	2.9	.4	2.3	.3
3	6.9	1.2	8.4	1.0	7.6	.4	8.5	.7	9.0	.6
4	7.1	.1	6.5	.2	6.5	.5	9.5	.4	5.8	.5
5	21.4	1.4	21.0	1.5	23.0	1.3	22.1	1.5	16.7	1.7
6	24.0	1.5	24.6	2.4	23.5	1.3	35.0	1.0	30.0	3.0
Extracts from kernels at indicated days after pollination										
Instar	5		10		15		20		30	
	Ex	Ck	Ex	Ck	Ex	Ck	Ex	Ck	Ex	Ck
1	1.1	0.7	0.6 ^b	0.7	1.5 ^b	2.1	0.7 ^b	0.7	0.6 ^b	0.6
2	4.2	.8	1.3	.3	1.6 ^b	2.8	3.1 ^b	2.2	.8 ^b	1.8
3	18.2	.7	4.8	.5	5.0 ^b	3.2	10.0	3.3	1.4 ^b	.9
4	0.8	.2	5.6	.1	0.7	0.0	1.7	.1	5.4	1.1
5	10.9	1.6	14.4	1.8	8.1	.6	14.0	1.5	8.0	5.4
6	23.4	2.5	22.6	3.6	41.9	5.7	34.7	3.4	25.7	2.8

^a Nonpollinated 3-day-old silks.

^b No significant (5% level of confidence) difference between extract and water check. All others were significantly different.

March 1970]

McMILLIAN ET AL.: RESPONSES OF CORN EARWORM LARVAE

375

Table 2.—Average areas^a (mm² of carrier) consumed per larva given a choice between carriers treated with extracts of corn silks or kernels of several ages.

Age ^b of plant part	Instar					
	1st	2nd	3rd	4th	5th	6th
<i>Silks</i>						
0 ^c	0.5 a	2.4 a	4.5 b	8.2 a	22.0 ab	27.8
3	.4 ab	1.4 b	4.3 b	7.1 a	20.8 b	25.3
6	.4 ab	2.1 a	6.7 ab	6.9 a	24.7 a	21.4
9	.3 b	2.1 a	7.6 a	7.8 a	24.9 a	29.8
12	.4 ab	2.3 a	5.5 ab	5.1 b	14.6 c	28.4
<i>Kernels</i>						
5	2.3 a	8.1 a	25.3 a	3.2 ab	20.5 a	35.2
10	1.1 b	4.3 b	11.5 b	3.5 ab	22.6 a	37.4
15	.8 b	2.6 bc	6.4 b	4.3 a	20.7 a	38.6
20	1.0 b	1.7 c	7.0 b	4.2 a	14.2 b	37.3
30	.9 b	1.6 c	9.4 b	2.5 b	13.0 b	30.0

^a Means followed by the same letter are not significantly different (5% level of confidence).^b Days after pollination.^c Nonpollinated 3-day-old silks.

nated silks and the extract of 5-, 10-, or 15-day-old kernels. Thus, maximum differences, if any, were to be obtained for the period that the larvae would normally be present and feeding on the plant. A 2nd part of the test involved evaluating the feeding responses of 4th instars to 2 extracts of nonpollinated silks and 12-day-old pollinated silks to determine whether feeding stimulation varied within a silk mass. For this part of the test the harvested silks were divided at the point of exposure at the husk tip. Then the extracts of exposed and unexposed silks were compared with one another and with a water check.

No preference at the 5% level of confidence (Table 3) could be detected between either pollinated or nonpollinated silk extract and the extract of 5-day-old kernels. First, 2nd, and 3rd instars preferred the extract of nonpollinated silk to that of 10-day-old kernels; 4th, 5th, and 6th instars preferred the extract of 10-day-old kernels to the extract of 12-day-old pollinated silks. These data plus the data in Table

2 clearly indicate that during the 4th stadium, the larvae changed their preference from silks to that of kernels.

First, 2nd, and 3rd instars preferred the extract of nonpollinated silk to that of 15-day-old kernels; the later instars preferred the extract of 15-day-old kernels to that of 12-day-old pollinated silks. Apparently, the early instars preferred the extract of silk or that of immature kernels, and the later instars preferred the extract of mature kernels, though they accepted the less preferred material when no choice was given.

When extracts of exposed and unexposed silks (Table 4) of both nonpollinated silks and 12-day-old pollinated silks were compared with a water check, all extracts stimulated feeding. However, the extract of exposed 12-day-old pollinated silks elicited more response than the extract of unexposed pollinated silks; the opposite was true for extracts of exposed and unexposed nonpollinated silks.

Bioassay 4.—Because the feeding stimulants used in the present tests and in earlier tests probably contained a complex of ingredients, an attempt was made to separate the feeding stimulant obtained from both nonpollinated silks and from 10-day-old kernels into 2

Table 3.—Average areas (mm² of carrier) consumed per larva given a choice between carriers treated with extracts of corn silks or kernels of several ages (days after pollination).

Instar	Choice					
	Silk vs.	5-day-old kernel	Silk vs.	10-day-old kernel	Silk vs.	15-day-old kernel
<i>3-day-old nonpollinated silks</i>						
1	1.1 ^a vs.	1.2	0.8 vs.	0.4	0.9 vs.	0.4
2	7.6 ^a vs.	4.6	6.3 vs.	3.8	11.0 vs.	1.6
3	11.9 ^a vs.	13.0	17.7 vs.	5.9	27.5 vs.	8.4
<i>12-day-old pollinated silks</i>						
4	2.6 ^a vs.	2.6	1.0 vs.	4.1	1.5 vs.	4.9
5	12.9 ^a vs.	13.8	4.9 vs.	14.8	7.3 vs.	15.3
6	11.5 ^a vs.	14.8	5.0 vs.	19.2	5.7 vs.	20.1

^a No significant (5% level of confidence) difference between extracts of silks and of kernels. All others were significantly different.Table 4.—Average areas^a (mm² of carrier) consumed per 4th instar given a choice between extracts of exposed and unexposed silk parts or either part and a water-treated check.

Choice	Silk age			
	3-day-old nonpollinated		12-day-old pollinated	
Exposed part vs. unexposed	2.4	vs. 4.2	19.4	vs. 1.8
Exposed part vs. water	5.4	vs. 0.2	29.2	vs. 0.6
Unexposed part vs. water	6.6	vs. .5	4.8	vs. .4

^a All differences were significant (5% level of confidence).

fractions each by exhaustive extraction with pyridine. The resultant pyridine-soluble and insoluble fractions of each plant part were taken to dryness at a reduced pressure at room temperature and stored in a freezer until the bioassay.

A quantitative measurement showed that 60% of the feeding stimulant extract of silks was soluble in the pyridine, while 10% remained insoluble. For unknown reasons, 30% was unrecoverable. A measurement of the water extract of kernels showed 70% to be soluble in pyridine and 25% insoluble. Five percent was not recoverable. A preliminary analysis using TLC verified that at least 2 simple sugars and 10 amino acids or peptides were present in the pyridine-soluble fraction while at least 1 amino acid or peptide and no simple sugars were detected in the pyridine-insoluble fraction.

Because the individual ingredients of the complex could be either biologically active or inactive for the various instars, the bioassay of these extract fractions was arranged as a series of 3 tests. First, the pyridine-soluble and insoluble fractions of both silks and kernels were compared with a water-treated check to determine whether feeding was elicited from each instar; in this test, each dish contained an extract treatment and a water-treated check. Second, the 2 fractions of each plant part were compared for preference by the various instars; in this test, each dish contained only treatments of the pyridine-soluble and insoluble fraction of a particular plant part. Third, larval feeding preference was monitored when offered a water-treated check, the original feeding stimulant, and the pyridine-soluble and insoluble fractions of a particular plant part; in this test, each dish contained the 4 mentioned treatments. Other bioassay techniques were as described.

Of the extracts of silks, only the pyridine-soluble fraction influenced feeding to any sizable extent (Table 5 A). However, the 5th and 6th instars did

respond more to the pyridine-insoluble fraction than to the water check, though the significant (5% level of confidence) preference for the pyridine-insoluble fraction disappeared when the pyridine-soluble fraction was offered instead of water.

The pyridine-soluble fraction of the water extract of corn kernels (Table 5 B) caused a significant (5% level of confidence) feeding response by all instars as did, with 1 exception, the pyridine-insoluble fraction compared with a water check. When the pyridine-soluble and insoluble fractions were compared with one another, no significant preference (at the 5% level of confidence) was noted for the 1st, 2nd, 3rd, or 5th instars, but the 4th instars preferred the insoluble fraction, and the 6th instars preferred the soluble fraction.

Thus, only the pyridine-soluble fraction (Table 6) appeared to influence feeding on silks, while both the pyridine-soluble and insoluble fraction influenced feeding on kernels. The responses obtained when a free choice was allowed among the unfractionated stimulant, the 2 fractions, and a water check for each of the 2 plant parts were in general agreement with the responses obtained in previous tests when a free choice among all fractions was not allowed. The feeding response elicited from the pyridine-soluble and insoluble fractions of each plant part appeared to be additive.

We feel that the occasional lack of significant differences at the 5% level of confidence as shown in Table 6 was caused by the inability of larvae to clearly distinguish among more than 2 treatments (particularly if some contained combinations of ingredients) and by a limitation on the amount that could be consumed by a single larva.

Field Test.—The field test was designed to monitor larval feeding down the corn ear over a period of days. Stowell's Evergreen sweet corn hybrid was planted in 2-row plots 30 ft long. The test was rep-

Table 5.—Average areas (mm² of carrier) consumed per larva given a choice between carriers treated with 2 fractions of a water extract of (A) corn silks and (B) corn kernels or either fraction and a water-treated check.

Instar	Choice							
	Pyridine-soluble fraction	vs.	{ Water check	Pyridine-insoluble fraction	vs.	{ Water check	Pyridine-soluble fraction	vs. { Pyridine-insoluble fraction
<i>A Extract of corn silks</i>								
1	3.0	vs.	2.0	1.5 ^a	vs.	1.9	2.7 ^a	vs. 2.0
2	5.6	vs.	0.9	4.8 ^a	vs.	1.2	3.3 ^a	vs. 3.4
3	20.4	vs.	1.6	13.1 ^a	vs.	5.9	11.0 ^a	vs. 11.1
4	3.3	vs.	.1	0.2 ^a	vs.	0.0	2.8 ^a	vs. 6.1
5	17.3	vs.	1.1	14.9	vs.	.9	16.3	vs. 8.2
6	12.3	vs.	.6	4.4	vs.	1.2	8.5	vs. 4.4
<i>B Extract of corn kernels</i>								
1	1.2	vs.	0.9	1.7 ^a	vs.	1.5	1.1 ^a	vs. 0.9
2	5.7	vs.	.7	12.6	vs.	2.1	3.5 ^a	vs. 4.5
3	28.1	vs.	.7	24.7	vs.	2.4	8.7 ^a	vs. 9.2
4	2.7	vs.	.3	2.8	vs.	0.2	1.9	vs. 4.7
5	19.9	vs.	1.0	19.6	vs.	1.3	11.1 ^a	vs. 8.6
6	29.4	vs.	6.3	34.6	vs.	4.5	21.3	vs. 12.3

^a No significant differences (5% level of confidence). All others were significantly different.

March 1970]

MCMILLIAN ET AL.: RESPONSES OF CORN EARWORM LARVAE

377

Table 6.—Average areas* (mm² of carrier) consumed per larva given a choice between carriers treated with a water extract of corn silks or kernels, 2 fractions of the water extract, and a water-treated check.

Extract	Instar					
	1st	2nd	3rd	4th	5th	6th
<i>Silk</i>						
Unfractionated (water extract)	0.9 a	1.8 ab	13.0 a	0.5 a	7.4 a	3.8 a
Pyridine-insoluble fraction	.2 b	1.4 ab	2.6 b	.0 b	0.6 b	0.6 b
Pyridine-soluble fraction	1.1 a	3.0 a	12.4 a	.6 a	6.0 a	4.6 a
Water check	.6 a	1.0 b	2.1 c	.0 b	.0 b	.8 b
<i>Kernel</i>						
Unfractionated (water extract)	.7 a	2.7 a	3.0 a	.5 a	.7 a	9.6 a
Pyridine-insoluble fraction	.6 a	2.3 a	2.6 a	.3 ab	.6 a	4.5 b
Pyridine-soluble fraction	.6 a	2.0 a	3.6 a	.2 b	.4 a	6.3 b
Water check	.5 a	0.5 b	0.3 b	.0 c	.1 b	.9 c

* Means followed by the same letter are not significantly different (5% level of confidence).

licated 10 times. All ear shoots were capped before the silk emerged. On 1 row, the silks were hand pollinated 3 days after emergence and infested with 3 1st instars. On the 2nd row, the silks were not pollinated, but they were infested 3 days after emergence. Then after 2, 4, 6, 8, 10, and 12 days, 5 ears in each plot of both treatments were harvested, the larvae were removed, and the depth of larval penetration was measured by the following scale: 0 = no damage, 1 = silk feeding, 2 = tip feeding, and 3+n = kernel damage class increased by 1 unit for each additional centimeter depth of larval penetration down the ear.

Larvae fed in the pollinated silk mass for ca. 8 days (Table 7 and Fig. 5) before they began inflicting damage to the kernels. These results agreed with the results of the feeding-preference tests (Table 3): the early instars chose silk extract as often or more often than kernel extract; later instars chose kernel extract as often or more often than silk extract. Penetration was much slower in nonpollinated ears and generally never reached the maximum that occurred in pollinated ears. Thus, the feeding preference of each instar appeared to synchronize with the changes in components in the developing plant parts and were in phase with the pollinated ear, resulting in maximum damage. When development of the larvae was out of phase with the nonpollinated ear, the older larvae

(4th instar) were apparently confused and searched for kernel constituents (mainly for the pyridine-insoluble fraction). Thus, we feel that the larval response to the pyridine-soluble fraction predominated when nonpollinated ears were offered, and that the response to the pyridine-insoluble fraction of the kernels was not manifested when the ear was not pollinated; thus normal penetration and feeding by larvae did not occur.

CONCLUSIONS

A series of bioassays involving the various instars of the corn earworm and a water extract of corn silks and kernels at several stages of maturation showed a close relationship between the amount of larval feeding and the presence of certain chemical constituents of the plant. The following may be concluded:

1. Water extract of silks in all stages of maturity elicited feeding response from all larval instars.

2. In general, the preference by instars among extract of silks was unclear; however, there may be a trend toward preference for younger silks.

3. The water extract of silks contains 60% pyridine-soluble ingredients and 10% pyridine-insoluble ingredients. The pyridine-soluble fraction caused more response by all larval instars and was significantly preferred over the pyridine-insoluble fraction by 5th and 6th instars.

4. Water extract of kernels in certain stages of maturation elicited a feeding response from only certain instars.

5. The 1st, 2nd, and 3rd instars preferred extract of immature kernels; the 4th and 5th instars preferred extract of mature kernels. The 6th instars preferred all kernel ages equally.

6. The water extract of kernels contains 70% pyridine-soluble ingredients and 25% pyridine-insoluble ingredients that caused feeding response by all instars except that the insoluble fraction did not stimulate the feeding of 1st instars. The 6th instars preferred the pyridine-soluble fraction and 4th instars preferred the pyridine-insoluble fraction.

7. All instars preferred the extract of nonpollinated silks and the extract of 5-day-old kernels

Table 7.—Progressive penetration* of earworm larvae on pollinated and nonpollinated ears of corn observed from 2 to 12 days after infestation.

Time after infestation (days)	Avg penetration ^b	
	Pollinated ears	Nonpollinated ears
2	0.8 a	0.7 a
4	2.9 b	.6 a
6	3.3 b	1.1 a
8	4.9 c	2.0 b
10	6.4 d	2.7 b
12	8.2 e	2.2 b

* Means followed by the same letter are not significantly different (5% level of confidence).

^b 0 = no damage; 1 = silk feeding; 2 = ear tip feeding; and 3+n = injury class increased by 1 unit for each additional centimeter of penetration (depth of feeding).

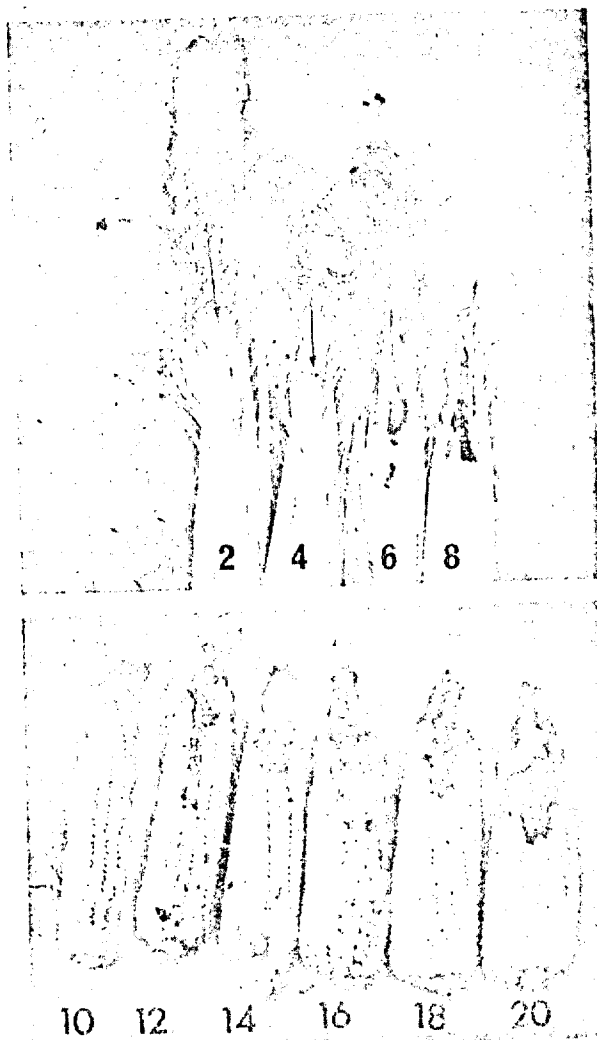


FIG. 5.—View of penetration and feeding by corn earworm larvae down the ear in 2-day increments for 20 days.

equally, but 1st, 2nd, and 3rd instars consumed more extract of nonpollinated silks than of 10- and 15-day-old kernels. The 4th, 5th, and 6th instars preferred extract of 10- and 15-day-old kernels to that of 12-day-old pollinated silks. The pyridine-insoluble fraction appeared to be the principal influence on 4th

instars, but both the pyridine-soluble and insoluble fractions influenced 5th instars, and the pyridine-soluble fraction had more influence on 6th instars.

8. Response to the pyridine-soluble and insoluble fractions of each plant part bioassayed appeared to be additive.

9. In general, the response of corn earworm larvae to extracts of silks and kernels bioassayed in the laboratory coincided with the progression of larval feeding observed on corn ears in the field. A synchronization of larval feeding preference with certain corn plant constituents, as influenced by insect and plant development, was evidenced.

10. Development of a method by which corn plants can be chemically fingerprinted to determine the reasons for resistance to the corn earworm may be nearer, based on the evidence that certain plant chemicals bioassayed in the laboratory stimulate larval feeding and that this feeding response is correlated with plant damage obtained under field conditions.

REFERENCES CITED

- Barber, G. W. 1944. Mineral oils, alone or combined with insecticides, for control of earworms in sweet corn. USDA Tech. Bull. 880. 83 p.
- McMillian, W. W., and K. J. Starks. 1966. Feeding responses of some noctuid larvae (Lepidoptera) to plant extracts. Ann. Entomol. Soc. Amer. 59: 516-9.
- McMillian, W. W., K. J. Starks, and M. C. Bowman. 1967. Resistance in corn to the corn earworm, *Heliothis zea*, and the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). Part I. Larval feeding responses to corn plant extracts. Ibid. 60: 871-3.
- Painter, R. H. 1951. Insect Resistance in Crop Plants. The Macmillan Co., New York. 520 p.
- Phillips, W. J., and G. W. Barber. 1933. Egg-laying habits and fate of eggs of the corn earworm moth and factors affecting them. Va. Agr. Exp. Sta. Bull. 47. 14 p.
- Poole, C. F. 1935. Corn earworm resistance in maize varieties at Davis, California. 1934. Proc. Amer. Soc. Hort. Sci. 32: 453-7.
- Starks, K. J., and W. W. McMillian. 1967. Resistance in corn to the corn earworm and fall armyworm. Part II: Types of field resistance to the corn earworm. J. Econ. Entomol. 60: 920-3.
- Starks, K. J., W. W. McMillian, A. A. Sekul, and H. C. Cox. 1965. Corn earworm larval feeding response to corn silk and kernel extracts. Ann. Entomol. Soc. Amer. 58: 74-76.
- Wiseman, B. R., W. W. McMillian, and R. L. Burton. 1969. Feeding response of larvae of corn earworm to water extracts of 16 host plants. J. Ga. Entomol. Soc. 4: 15-22.

Osol, A. and G. E. Farrar, Jr., (Eds.), 1967

The Dispensatory of the United States
of America, 25th Edition

J. B. Lippincott Company, Philadelphia

Part II, p. 1932

THE AMERICAN JOURNAL OF PHARMACY.

AUGUST, 1886.

PROXIMATE ANALYSIS OF STIGMATA MAYDIS.

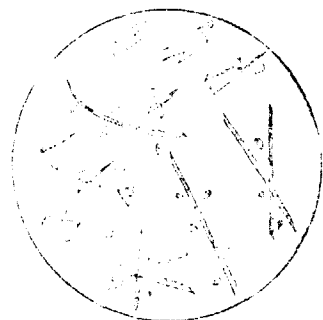
By C. J. RADEMAKER, M.D., AND JOHN L. FISCHER, PH.G.

Fifty grams of stigma maydis were treated with petroleum spirit at a boiling point below 112° F. This extracted 5.25 per cent. of a light yellow fixed oil which saponified readily with caustic potash, and solidified at a temperature of 50° F. No volatile oil was found in the petroleum extract, nor was any obtained by distillation. The oil was soluble in chloroform, ether and petroleum spirit, but was insoluble in alcohol. The action of nitrous acid upon this oil produced no change of color, but the oil solidified in a few hours.

The drug after drying was next exhausted with ether, this extracted 2.25 per cent. of solid matter; one (1) per cent. of this was soluble in water. This aqueous solution had an acid reaction, the other 1.25 per cent. proved to be resin and chlorophyll. Upon evaporating the aqueous solution to dryness, redissolving the residue in ether and allowing the ether to evaporate spontaneously, a colorless acid crystalline principle was left.

The original drug after being dried was then treated with absolute alcohol; this extracted 3.25 per cent. of solid matter, 2 per cent. of this proved to be resin and coloring matter, the other 1.25 per cent. proved to be an acid, identical with the acid found in the ether extract.

This acid was first discovered by Dr. Vautier (*Arch. Med. Belges*), and he named it *maizenic acid*. It is freely soluble in water, ether and alcohol, but insoluble in petroleum spirit. It decomposes the alkaline carbonates, and its salts are crystallizable, the potash salt crystallizing in rhomboidal prisms.



MAIZENIC ACID X700.

To water the drug yielded 12.50 per cent. of solid matter. This was redissolved in water and then made alkaline by caustic potash. The solution was then successively treated (agitated) with ether, chloroform and petroleum spirit, but no crystalline principle was obtained. The aqueous extract consists principally of sugar, gum and extractive matter.

That portion of the drug that was insoluble in water, gave to a 2 per cent. solution of caustic soda, 3.50 per cent. of solid matter, consisting of albuminoids, phlobaphene, etc., and to a 2 per cent. solution of hydrochloric acid, the drug gave 5.50 per cent. of salts with a small amount of extractive matter.

Upon bleaching the final residue, washing and drying, 37 per cent. of cellulose was obtained.

Another portion of the drug yielded 20 per cent. of tincture. The following shows the amount of the most important constituents:

Fixed oil.....	5.25	petroleum spirit extract.
Resin, crystalline principle and chlorophyll....	2.25	ether extract.
Resin, crystalline principle and chlorophyll....	3.25	alcohol extract.
Sugar, gum and extractive.....	10.50	water extract.
Albuminoids, phlobaphene, etc.....	3.50	from alkaline solution.
Salts and extractive.....	5.50	from acid solution.
Cellulose.....	37.00	
Water.....	20.00	
	96.25	

LOUISVILLE, JULY 4, 1886.

INVESTIGATIONS OF THE BARK OF *FRAXINUS AMERICANA*, LIN.

In 1882 Howard M. Edwards reported having obtained evidence of the presence of an alkaloid in the bark of the American white ash (Am. Jour. Pharm., 1882 pp. 99 and 283). A further examination of this principle has been made during the past year, and two theses were presented last winter to the Philadelphia College of Pharmacy, from which the following brief abstracts are made:

George W. J. Hoffman, Ph.G., used for his experiments the trunk bark, deprived of the suberous layer. A decoction was made of 24 troy ounces of the bark with water acidulated with hydrochloric acid; milk of lime afforded a light green precipitate, which was washed, dried and powdered; it yielded nothing to hot alcohol or ether. On treating with diluted alcohol, acidulating the filtrate with sulphuric acid, treating with animal charcoal and evaporating, a few

light brownish crystals were obtained, containing calcium sulphate and giving very slight reactions with Meyer's reagent and with solution of iodine. By precipitating the filtrate from the fine precipitate with tannin, and decomposing with sulphuric acid, a calcium salt was obtained, but no indications of an alkaloid.

A tincture was made with 20 per cent. alcohol, and evaporated; the residue treated with strong alcohol left a gummy matter behind, the filtrate was concentrated, mixed with water, and tested with tannin, iodine and picric acid, which did not affect the clear liquid; but Meyer's reagent gave a faint cloudiness. On precipitating the liquid with lead acetate and freeing the filtrate from lead, it was free from bitterness, yielded no reaction with the usual reagents for alkaloids, and no alkaloid could be obtained from it.

A tincture made with 15 per cent. alcohol gave results similar to the preceding. On treating the precipitate by lead acetate with ether, and evaporating the latter, a yellowish, apparently crystalline residue was obtained, which was soluble in alcohol and water and had the odor and taste of the drug.

A tincture made with strong alcohol was concentrated, mixed with water, which precipitated a light-colored resin, and the filtrate variously treated without yielding an alkaloid. It was noticed that ferric chloride caused a coloration similar to that produced by gallic acid; and that nitric acid in excess caused a blood red color both in aqueous and alcoholic solutions.

The bark collected by the author showed the same behavior as the commercial bark.

Daniel W. Cahill, Ph.G., collected a quantity of the root bark and stem bark, which were deprived of the corky layers and analyzed according to the plan of Dragendorff, with the following results:

	Root Bark.	Trunk Bark.
Organic matter extracted by petroleum benzine.....	30	20
" " " " strong ether.....	36	36
" " " " absolute alcohol.....	14.68	11.00
" " " " water.....	10.33	9.14
" " " " dilute alkali.....	.89	.83
" " " " dilute acid.....	4.20	2.16
Loss by bleaching.....	3.24	2.91
Moisture.....	6.76	7.23
Ash.....	5.92	5.10
Residue.....	15.95	56.09
Loss.....	7.05	4.18

The benzin extract consisted of wax, and in that of the root bark a little volatile oil was found. The resinous ether extract communicated to water a yellowish color and a bitter taste. More of the bitter principle was found in the alcoholic extract, the aqueous solution of which did not reduce Fehling's solution, yielded a white precipitate with tannin, reduced gold from the chloride, gave with phosphomolybdic acid a dark blue-green color and yellowish white precipitate, and was not disturbed by potassio-mercuric iodide, platonic chloride, or picric acid. The extract treated with potassa gave off ammonia. The aqueous solution rendered alkaline was shaken with chloroform, the latter evaporated, the residue dissolved in water, and this solution evaporated over sulphuric acid. The residue was crystalline, very bitter, and dissolved in hydrochloric acid without color, in nitric acid with a light yellow color, and slowly in sulphuric acid with a brownish red color, changing to dark purplish brown on heating. The resinous residue of the alcoholic extract still imparted to water a light yellowish color, changing to dark brown by alkali, and to yellowish again when acidulated.

The aqueous extract of the bark contained glucose and was free from tannin. The alcoholic extract of the bark represents the medicinal virtues.

An analysis of the trunk bark (it seems that the corky layer was not removed) was made at the University of Wisconsin, by Edw. Kremers. (Contributions from the Department of Pharmacy, Univ. Wis., 1886, p. 19-26.) The distillate with water showed traces of volatile oil. The distillate with potassa gave no reaction for a volatile alkaloid; the liquid in the flask attracted attention by its intense greenish-blue fluorescence. The infusion with acidulated water afforded precipitates with iodine and with potassio-mercuric iodide; likewise after precipitating with ammonia, filtering and acidulating, and also the ether residue from the alkaline liquid. Similar results were obtained after mixing the bark with lime and extracting with alcohol. Petroleum benzin extracted from the bark 0.52 per cent. of yellow fatty matter of the consistence of lard; and other afterwards took up 2.03 per cent. of a soft resinous substance.

By a process similar to that of Salm-Horstmar for fraxin the precipitate with basic lead acetate yielded an amorphous glucoside readily soluble in water and alcohol, showing a strong blue fluorescence in alkaline, but not in acid solutions, and on boiling with dilute hydrochloric acid yielding sugar and an amorphous principle closely related

to fraxetin. The filtrate from the lead precipitate, freed from lead, contained sugar, and tannin precipitated from it a small amount of amorphous bitter principle. The bark exhausted with alcohol, was treated with hot water; this liquid contained gummy matter and mannite.

The tincture obtained with hot alcohol from 250 gm. of bark dried with milk of lime, was concentrated, acidulated with sulphuric acid, the liquid filtered, made alkaline with ammonia and shaken with ether. The ether residue on being taken up with acidulated water gave reactions with iodine and potassio-mercuric iodide; and on being evaporated spontaneously yielded crystals, which were freed from an amorphous dark colored mass, and were then almost insoluble in cold alcohol or water, but separated from the hot solution in slender needles, which are slightly acid, neutral, melting at 166° C., soluble in ether and with a yellow color in ammonia, the latter solution becoming colorless with hydrochloric acid and gradually assuming a purplish tint. These crystals are probably *fraxetin*. Treatment of the alkaline solution with chloroform gave a dark purplish solution from which more of the crystals could be obtained, also solutions giving alkaloidal precipitates.

The precipitate with lead acetate from a tincture of the bark contained a soft substance of a somewhat resinous nature, which was partly soluble in hot water, the solution giving reactions with alkaloidal reagents.

All the above experiments render the existence of an alkaloid in white ash bark more than doubtful, without throwing much light upon the bitter principle. Mr. Kremers' results indicate a probable relation of at least one constituent to fraxin and fraxetin; but these principles as obtained from the barks of the European ash and of the horse chestnut are still very imperfectly known.

POLYGONUM HYDROPIPER.

By C. J. RADEMAKER, M. D.

That the active principle of this drug, which I first described in the AMERICAN JOURNAL OF PHARMACY, November, 1871, is neither gallic nor tannic acid, as was stated by Messrs. H. Trimble and H. J. Schuchard, I think I have proven beyond a doubt (see this JOURNAL, June, 1886, p. 279). In the July number, p. 356 of this JOURNAL, I see that the gentlemen are considerably agitated over my criticism of their article, that they can not resist the temptation of

Spector, W. S. (Ed.)

1956

Handbook of Toxicology Vol. I: Acute Toxicities

W. B. Saunders Company
Philadelphia, Pennsylvania

Pages 60-61; 298-301

Corn Earworm Larval Feeding Response to Corn Silk and Kernel Extracts¹

K. J. STARKS,² W. W. McMILLAN,² A. A. SEKUL,³ AND H. C. COX²
Entomology Research Division, Agr. Res. Serv., USDA, Tifton, Georgia

ABSTRACT

Corn earworm larvae, *Heliothis zea* (Boddie), were subjected to filter paper treated with extracts of ether-fixed, lyophilized, or alcohol-fixed sweet corn silks and kernels. Results from all 3 methods of fixing indicated that average feeding response to the first water extract was as much as 29 times stronger than that from water alone. No feeding response was noticed from the ether or alcohol layers. The feeding stimulant and/or arrestant, not yet

chemically identified, is relatively heat-stable, insoluble in ether and alcohol, but highly soluble in water. The feeding response became more pronounced as the concentration was increased. After extraction the feeding stimulant dissipated rapidly. Different sugars at concentrations ranging from 0.05 to 3.0 molar elicited some feeding response, but this response did not approach the magnitude of that from the plant extracts.

Numerous authors have reported findings related to host plant resistance in sweet corn to the corn earworm, *Heliothis zea* (Boddie). One purpose of the research on host plant resistance now in progress at the Southern Grain Insects Investigations Laboratory at Tifton, Georgia, is to determine whether extracts of sweet corn silks and kernels are attractive to and elicit feeding responses from the corn earworm. The term "feeding stimulant" has been defined by Dethier et al. (1960) as a chemical which elicits feeding. He also defined an "arrestant" as a chemical which causes insects to aggregate in contact with it. Extracts of this nature have been obtained from host plants of the European corn borer, *Ostrinia nubilalis* (Hübner) (Beck 1956); the Mexican bean beetle, *Epilachna varivestis* (Mulsant) (Lippold 1957); the boll weevil, *Anthonomus grandis* Boheman (Keller et al. 1963); the alfalfa weevil, *Hypera postica* (Gyllenhal) (C. Blickenstaff 1963, personal communication); and the catalpa sphinx, *Ceratomia catalpae* (Boisduval) (Nayar and Frienkel 1963); and other insects.

METHODS

In tests with the corn earworm, freshly harvested silks and kernels from P-39, an earworm-susceptible sweet corn inbred, were quick-fixed by 3 methods.

Ether Fixation.—By this method 400 g of plant material were placed immediately after collection in half-gallon fruit jars containing 1000 ml of anhydrous ether. These jars were then refrigerated at 80°C until a convenient time for extraction. The liquid (ether plus some plant water) was then placed in a separatory funnel and the water layer separated from the ether layer. The ether layer was allowed to evaporate down to 20 ml of liquid under a vented hood. This liquid extract was marked ether-fixed fraction I.

The water layer removed from the ether was recombined with the plant residue material along with 1000 ml of distilled water. This mixture was then blended for 5 min before being filtered several times. The water layer was centrifuged at 2000 rpm for 15 min. The precipitate was labeled ether-fixed residue II. The supernatant was placed in a lyophilizer and distilled

under vacuum at -70°C to 20 ml with a Dry Ice-acetone bath. The water residue and distillate were marked ether-fixed water fraction III and VI, respectively.

To insure the removal of all water solubles, 1000 ml of distilled water were again added to the original plant material as described above. The same procedure was carried out and the resulting liquid marked ether-fixed residue water V. The residue was discarded.

Lyophilization.—Before lyophilization 400 g of plant material were blended with 1000 ml of distilled water, as outlined previously. The distillate was collected, labeled lyophilized distillate water I, and stored under refrigeration until testing. Next, 11 g of dry plant residue was blended with 300 ml of distilled water for 5 min. This blend was allowed to soak for 2 hr, after which it was filtered. The liquid phase was centrifuged at 2000 rpm for 15 min. The precipitate was labeled lyophilized residue II. Again the liquid was placed on the freeze dryer and concentrated down to 20 ml. The water residue and distillate were marked lyophilized water fraction III and VI, respectively. Distilled water was added to the original plant material twice more, and the same extraction procedure as described above were carried out, with the exception that during the last extraction the blend was boiled for 5 min. The resulting fractions were marked lyophilized residue water V and VI, respectively. The residue was discarded.

Alcohol Fixation.—The same procedure was used for alcohol fixing as for the ether fixing, except that the plant material was boiled in 95% ethanol for 15 min, and the alcohol and water were then separated by fractional distillation. All fractions were labeled alcohol-fixed.

Treatment.—Fourth-instar corn earworm larvae reared on an artificial diet slightly modified from that of Berger (1963) were placed individually in quadrant petri dishes (Fig. 1). Each of 2 quadrants contained sections of filter paper impregnated with 0.1 ml of test material; the other 2 quadrants contained filter paper impregnated with 0.1 ml of distilled water which served as controls. All filter-paper sections

¹ Accepted for publication June 1, 1964.

² Entomologist.

³ Biochemist.

* Mention of this proprietary product does not necessarily imply its endorsement by the USDA.

January 1965]

STARKS ET AL.: CORN EARWORM FEEDING RESPONSE

75

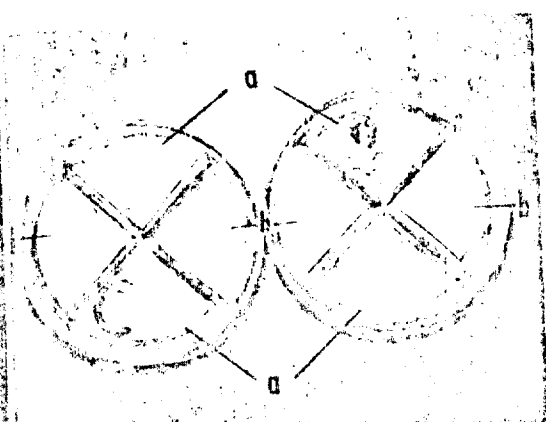


FIG. 1.—Representative feeding of corn earworm larvae on plant extract-treated filter paper (a) and on water-treated filter paper (check) (b).

re allowed to air dry before larvae were introduced. Each larva was allowed to roam and feed indiscriminately in the dish for about 18 hr. after which the filter paper sections were removed and the total area of paper consumed (in mm²) was determined. Sixteen replications of 5 dishes were set up for each extract.

In addition to the aforementioned tests, several sugars were screened for corn earworm feeding response. The procedure for these tests was similar to that used for testing plant extracts, except that different concentrations ranging from 0.05 to 3.0 molar were used. The sugars tested were sucrose, dextrose, fructose, trehalose, D-xylose, mannose, melibiose, galactose, lactose, rhamnose, and raffinose.

RESULTS AND DISCUSSION

By all 3 methods of plant fixation we were successful in producing extract fractions containing a feeding stimulant and/or arrestant from both silks and kernels of sweet corn (Table 1). The second fraction (III water residue) obtained from each fixation produced the greatest feeding response. Subsequent water fractions produced little or no response, indicating nearly total stimulant extraction in the first water fraction. We obtained no response from either the alcohol or ether fractions or from precipitate residues II and IV or distillate fraction IV. The average feeding response ratio to water fractions from ether-fixed and lyophilized plant tissue was about twice that obtained from the alcohol-fixed tissue. On an average the feeding response to the concentrated plant extract water fraction was 13 to 20 times as great as the response to the water-treated check. Apparently, response to the stimulant was correlated directly with the concentration, since little response was noted when the concentrated extracts were diluted 20 times.

The feeding stimulant is relatively heat stable (will withstand boiling for 1 min), nonvolatile at -70°C, 0.2 mm Hg, insoluble in ether or alcohol, but highly soluble in water. Continued testing has shown very little activity reduction in the stimulant while the

Table 1.—Feeding response of corn earworm larvae subjected to filter paper treated with ether, lyophilized, or alcohol-fixed plant extract fractions or with water.

Fraction	Area of paper consumed per larva (mm ²) ^a		
	Water check	Extract	Ratio
<i>Ether</i>			
Silks			
I ether	0.2	0.3	1:1
III water residue	.6	16.3	1:27
V water residue	.8	1.4	1:1
Kernels			
I ether	.4	0.3	1:1
III water residue	.4	9.6	1:24
V water residue	.3	0.2	1:1
<i>Lyophilized</i>			
Silks			
I distillate water	.1	0.1	1:1
III water residue	.9	20.6	1:23
V water residue	6.0	18.0	1:3
VI water residue	4.0	12.0	1:3
Kernels			
I distillate water	0.1	0.1	1:1
III water residue	1.2	34.5	1:29
V water residue	1.0	6.3	1:6
VI water residue	0.8	3.4	1:4
<i>Alcohol</i>			
Silks			
I alcohol	1.5	2.0	1:1
III water residue	0.9	12.0	1:13
V water residue	3.1	13.0	1:4
Kernels			
I alcohol	1.2	1.1	1:1
III water residue	3.4	45.9	1:14
V water residue	8.2	25.8	1:3

^a Each value represents the average of 80 larvae.

^b Ether-fixed fractions II and IV, lyophilized fraction II, and alcohol-fixed fractions II and IV gave no increase in feeding when compared with the control.

plant tissue remains in the fixed stage. Considerable reduction of activity occurs, however, once the stimulant is processed. A 50% drop in activity has been detected in a 14-day-old extract.

Tests in which we compared various sugar solutions at different concentrations against a water check showed that a feeding response was elicited (Table 2). Increasing the sugar concentration intensified feeding only slightly. Feeding increased to a maximum response of about 1:5 in favor of the sugar. Total area of paper eaten per larva was appreciably less in the tests with sugar than in the tests with plant extracts. Thus, it seems feasible that something other than sugar (although possibly closely related) produced a response in the plant extracts.

The feeding response was not significantly altered by filtering the extract through Norit-A⁴.

Maxwell et al. (1963) discussed practical applications of a similar stimulant. Presumably, success in some field uses of an arrestant-stimulant would depend on processed extracts overcoming the arrestant-

⁴ Mention of this proprietary product does not necessarily imply its endorsement by the USDA.

Table 2.—Feeding response ratio of corn earworm larvae fed on sugar solutions at various concentrations vs. a water check.^a

Sugar	Concentration (molar) ^b			
	0.50	1.0	2.0	3.0
Sucrose	1:4	1:4	1:3	1:3
Dextrose	1:3	1:4	1:3	1:3
D-Fructose	1:2	1:4	1:4	1:4
Trehalose	1:1	1:3	1:2	1:3
D-Xylose	1:1	1:2	1:2	1:2
Mannose	1:1	1:1	1:3	1:2
Melibiose	1:1	1:1	1:3	1:3
Galactose	1:1	1:1	1:1	1:2
Lactose	1:1	1:1	1:1	1:2
L-Rhamnose	1:1	1:1	1:1	1:1
Raffinose	1:1	1:1	1:1	1:1

^a All ratios are to the base 1 for water.

^b No increased response was obtained when a 0.05 M solution of any of the sugars was compared with the control.

stimulant present in the growing plant tissues. In a preliminary test with the corn kernel extract, the same ratio of feeding was obtained on extract-treated corn leaves as on filter paper when these substrata were compared with water-treated leaf tissue and filter paper, respectively.

ACKNOWLEDGMENT

The authors thank Fowden G. Maxwell and Johnie N. Jenkins, both of this Division, for their helpful suggestions in the conduct of this research.

REFERENCES CITED

- Beck, S. D. 1956. Nutrition of the European corn borer, *Pyrausta nubilalis* (Hbn.). IV. Feeding reactions of first instar larvae. Ann. Entomol. Soc. Amer. 49: 399-405.
- Berger, R. S. 1963. Laboratory techniques for rearing *Heliothis* species on artificial medium. USDA, Res. Serv., ARS-33-84: 4 p.
- Dethier, V. G., L. B. Browner, and C. N. Smith. 1963. The designation of chemicals in terms of response they elicit from insects. J. Econ. Entomol. 53: 13.
- Keller, J. C., F. G. Maxwell, J. N. Jenkins, and T. E. Davich. 1963. A boll weevil attractant from cotton. J. Econ. Entomol. 56(1): 110-1.
- Lippold, P. C. 1957. The history and physiology of host specificity of the Mexican bean beetle, *Epilachna varicornis* (Muls.), Coleoptera, Coccinellidae. Ph.D. Thesis, Univ. of Illinois, Urbana. 146 p.
- Maxwell, F. G., J. N. Jenkins, J. C. Keller, and W. E. Parrott. 1963. An arrestant and feeding stimulant for the boll weevil in water extracts of cotton leaf parts. J. Econ. Entomol. 56: 449.
- Nayar, J. K. and G. Fraenkel. 1963. The chemical basis of the host selection in the catalpa sphinx, *Ceratomia catalpae* (Lepidoptera, Sphingidae). Ann. Entomol. Soc. Amer. 56: 119-22.

Stecher, P. G. (Ed.)

1968

The Merck Index -- An Encyclopedia
of Chemicals and Drugs, 8th edition

Pages 97; 105; 214; 494; 621

ON THE NITROGEN FREE COMPONENTS OF CORN SILK. I.

(By) Kazue Tsukinaga

Table of Contents

1. Introduction
2. Preparation of Samples
3. Qualitative Tests
4. Quantitative Analysis
5. Products of Hydrolysis
6. Summary

I. INTRODUCTION

Corn is a kind of farm products belonging to the Gramineae, with a scientific name of *Zea Maize* L. It is an important plant. Corn silk (style or stigma) comprises a viscous material contained in a long empty tube, with its end divided into two parts. Its length measures 6 to 12", and it is covered with short hair. After pollination, it gradually dries up. There are many papers on the components of corn, but the components of corn silk have rarely been investigated. In 1918, Dutcher and Collotzi (1) reported that corn silk contained soluble vitamins, and the presence of phytosterin was mentioned by Miake (2) in 1921. Miake (3) also studied the enzymic action of corn pollen, and discovered that it contained such enzymes as amylase, sucrase, pepsin, tripsin, kymase, and peroxydase, but failed to observe any activity of maltase, glycose, emulsin, urease, oxydase, katalase, or elepsin. Miake also compared the diastase activity and the moisture and ash contents of 10 types of corn.

Fred and Peterson (4) carried out a study on corncobs. They reportedly obtained approximately 30 - 40% xylose by the hydrolysis of corncobs, and manufactured lactic acid by the reaction of xylose and *Lactobacillus pentoaceticus* u. sp. Monroe (5) subjected the viscous material contained in corncobs to acid cleavage and obtained furfural. He reported that the reaction of this compound with an sulfidated alkali or phenol resulted in a dye or a resinous material for paints. With regard to corn stalks, Kerr and Stewart (6), and Perold (7) confirmed the presence of sucrose, and described its practical value. The papers on the chemical properties of corn silk are relatively few, but many papers have been published with regard to its utilization.

In Japan, it has long been commonly used as a diuretic, and frequently prescribed even by physicians. For instance, the base material of Pistin is corn silk. According to the U. S. Pharmacopoeia (8), corn silk is also designated as *Zea*, or *Maidis stigma*. Rademaker and Fischer (9) reported that dry corn silk contained 2.25% maizenic acid, which is soluble in water, methanol, and ether but insoluble in benzene, oil, fat, resin, chlorophyll, sugar, albuminoids, phlobaphene, salts, cellulose and water. In the U. S., corn silk is recognized as a diuretic effective particularly for the treatment of renal disorders, cystitis, and lithangiuria. It is also used for the treatment of gonorrhea. Landrent (10) further advocated its therapeutic effect on hydropic cardiac condition as a cardiac stimulant. In Japan, Honma and Shiratori reported an observation of similar action.

2. PREPARATION OF SAMPLES

Samples of corn silk were collected from the garden of the Manchurian Railroad Agricultural Test Laboratory from early August through early September. They were dried and pulverized, and stored in air-tight jars. (Grade - regular).

3. QUALITATIVE TESTS

A. SEPARATION OF PHYTOSTERIN FROM ETHER INFUSION

Phytosterin was separated by Boemer's method (11). One hundred g of the sample was infused in ether, and, after the ether was eliminated, 50 cc of an ethanol solution of caustic potash (30 g of caustic potash was dissolved in 1 liter of 95% ethanol) was added. The mixture was then boiled over water bath with a reflux condenser, thereby saponifying the mixture. The ethanol was distilled out and 30 cc of water was added to the residue. After the precipitate became dissolved, the contents were transferred to a separating funnel, and ether was added. The mixture was shaken, thereby separating the ether soluble materials, and, after the ether was eliminated, the fat that failed to saponify was again subjected to the same saponification procedure, and transferred to a separating funnel, thereby separating ether soluble materials. When the ether was eliminated, colorless needle crystals were obtained along with a waxy material. The crystals were purified, and impurities, removed. Then, the crystals were discolored with ethanol and bone charcoal, and recrystallized from absolute ethanol, which yielded colorless plate crystals. The qualitative analysis of the crystals revealed the following properties:

- a. The crystals are soluble in ethanol, ether, and chloroform.
- b. Those crystallized from the ether solution are silk-like needle crystals, whereas those recrystallized from the ethanol solution, colorless prismatic plate crystals.
- c. The melting point is 137.5°C .
- d. The above crystals were boiled in an evaporating dish along with glacial acetic acid, dried by evaporation over water bath, and combined with absolute ethanol. The mixture was dissolved by heating and cooled. The crystals thus obtained had a melting point of 131° .
- e. The crystals were transferred to a glass plate and sulfuric acid was added (a mixed solution of concentrated sulfuric acid and water at 5 : 1). Its microscopic examination revealed a deep reddish purple coloration, and a purplish green and a red colorations when iodine and potassium iodide were added.
- f. The above crystals were dissolved in chloroform, and sulfuric acid with a specific gravity of 1.76 was added drop by drop. The upper chloroform layer developed a purple coloration, and the sulfuric acid layer released a greenish fluorescent light in reaction to a reflected ray, but a reddish coloration in response to a transmitted light.
- g. The above crystals were dissolved in a mixed solution of acetic anhydride and chloroform, and a drop of concentrated sulfuric acid was added, upon which a rosy coloration was developed, and the color changed to bluish green several hours later.
- h. The crystals were wetted with concentrated sulfuric acid, and the sulfuric acid was permitted to evaporate at low temperature, upon which a yellow coloration was observed. Then, ammonia was added, which produced a red coloration.

- i. The crystals were moistened with concentrated sulfuric acid, and, after ferric chloride was added, the sulfuric acid was permitted to evaporate, which produced a purple coloration.
- j. The crystals were placed in a test tube, and permitted to sublime, upon which drops of brilliant oil were formed.

Summarizing the above results, the unsaponified material obtained from the ether infusion is phytosterin ($C_{27}H_{46}O$). Organic acids were also found in the ether infusion, but the yields were minute, and no qualitative analysis was performed.

B. ETHANOL INFUSION

1. SEPARATION OF INORGANIC MATERIALS FROM THE ETHANOL INFUSION

One kg of air-dried corn silk was placed in a 5-l flask, and 2.5 l of absolute ethanol was added. The mixture was infused with a reflux condenser, and the ethanol infusion was filtered out. The same procedure was repeated 3 times, and the ethanol solution was subjected to vacuum distillation, thereby eliminating the ethanol. Upon evaporation, the residue became a syrup, and was dried in a sulfuric acid drier. The resultant syrup amounted approximately 8 g. It was noted that crystals were gradually formed in the drier at an increasing rate. An attempt was made to separate the crystals, by treating them with absolute ethanol but the crystals did not dissolve in the ethanol. The crystals were filtered out, and dried, which yielded approximately 1 g of crystals. They were dissolved in a small amount of water, and recrystallized several times, which yielded 0.6 g of white crystals. Microscopic examination revealed white dice-like crystals of the regular system. They had a bitter taste, but were not deliquescent. Although the crystals are insoluble in ethanol or concentrated hydrochloric acid, they were readily soluble in water. Qualitative analysis revealed the following properties:

- a. When heated on a platinum plate, the crystal water diminished, and a white powder remained, which indicates that the material is an inorganic compound.
- b. When a silver nitrate solution was added to an aqueous solution of the crystals, a white turbidity was produced, indicating the presence of chlorine.
- c. A mixture of hydrochloric acid and an aqueous solution of the crystals was heated, and barium chloride was added. No precipitation of barium sulfate was noted.
- d. When an ethanol solution of phenolphthalein was added to its aqueous solution, the mixture maintained a state of neutrality.
- e. When a mixture of a tartaric acid solution and an aqueous solution of the crystals was permitted to evaporate, fine, brilliant crystals were obtained. Microscopic examination revealed colorless, rhomboidal pillar crystals, with close resemblance to the crystals of potassium bitartrate.
- f. An aqueous solution of crystal was evaporated and ignited. A platinum hydrochloride solution was added, and the mixture was permitted to evaporate, then examined under the microscope. The crystals were extremely similar to those of K_2PtCl_6 , and did not dissolve in 80% ethanol.
- g. After the crystals were ignited, a 0.1 g portion of them was dissolved in water at a total quantity of 25.0 cc, and a 2.5 cc portion of it was transferred for the quantitative determination of chlorine and

potassium. The following results were obtained.

Experimental value		Calculated value	
K ₂ PtCl ₆	0.0319 g	Potassium	0.0051 g
N/20 Silver nitrate solution		Chlorine	0.0047 g
	2.7 cc		

Then, the rates of potassium and chlorine for 100 parts of potassium chloride were obtained.

Calculated value		Theoretical value	
Potassium	52.04%		52.44%
Chlorine	47.96%		47.56%

On the basis of the above results, the dice-like white crystals of the regular system are believed to be potassium chloride.

2. SEPARATION OF SUGARS FROM ETHANOL INFUSION

The ethanol was eliminated from the ethanol solution, from which the crystals had been eliminated, over water bath, and the remainder was transformed into a syrup at low temperature. Impurities were eliminated by reversing the procedure, which resulted in approximately 7 g of syrup. The yield of syrup was 7 g for the first time, 6 g for the 2nd time, and 8 g for the 3rd time, an average of 7 g. The qualitative determination of syrup revealed the following properties.

- Water soluble, and sweet.
- The aqueous solution of the syrup reduces Fehling solutions.
- Hydrolysis with hydrochloric acid resulted in a minimal increase in its reducing power.
- Molisch's reaction, positive.
- Seliwanoff's reaction, negative.
- Pinoff's reaction, negative.
- Neuberg's reaction, negative.
- A large amount of potassium saccharate was obtained.
- The formation of mucic acid was negative.
- Pentase reaction, by the hydrolysis with hydrochloric acid, was negative.
- The formation of phenylhydrazone was negative.
- A mixture of 2 g of syrup, 2 g of phenylhydrazine hydrochloride, 3 g of sodium acetate, and 2.0 cc of water was heated over water bath, which produced a large amount of osazone. Microscopic examination revealed that the osazone was needle crystals similar to glucosazone. The osazone was filtered out and washed with hot water. A part of it became dissolved, and reprecipitated upon cooling of the wash liquid, but a greater proportion of it was insoluble. The insoluble osazone was yellow needle crystals, aggregating in a star-like or pine needle-like fashion, and sparingly soluble in water, methyl alcohol, and ether, but readily soluble in ethyl alcohol and acetone. These crystals were divided into two portions, and recrystallized from 60% ethanol and acetone. After the crystals were separated and dried, their melting point was measured. Mp. 202-204°C. The hot water-soluble osazone was filtered out, and treated in the same manner. Its shape and property was same as those of the other fraction, but the melting point was 200-202°C.

From the above results, the former resembles the glucosazone described by Fischer and Tiemann, and Kees (11) in shape and property. The lower melting point of the latter may be due to impurities. Since the quantity was minute, confirmation was omitted.

Summarizing the above results, the syrup obviously contains glucose.

4. QUANTITATIVE ANALYSIS

A. ORGANIC CONSTITUENTS

Ordinary components of the above sample were determined by normal method, but the quantitative determination of special components followed the procedure described below.

1. PENTOSAN AND METHYLPENTOSAN

A 0.5 g portion of the sample was used for the determination procedure employed by Ellet and Tollens (12) and Oshima and Kondo (13). The calculation of pentosan was based on the table prepared by Tollens and Krobe.

2. REDUCING SUGARS AND NONREDUCING SUGARS

For the determination of reducing sugars and nonreducing sugars, a 1 g portion of the sample was placed in a flask with 80% ethanol, and was infused over water bath equipped with a reflux condenser and filtered 3 times. The residue was transferred to a filter paper by decantation, and washed with the previously mentioned ethanol. The filtrates were combined, and subjected to vacuum distillation, thereby eliminating the ethanol, and impurities were filtered out. Then, the filtrate was adjusted to 250 cc, and a part of it was subjected to quantitative determination of reducing sugars and the other portion was combined with hydrochloric acid until a 2% solution was obtained. The resultant solution was boiled in a hot water bath for 20 minutes. The solution was neutralized at a total quantity of 25 cc, and a part of it was subjected to the determination of potassium cyanide.

3. GALACTAN

A 5 g portion of the sample was treated with nitric acid with a specific gravity of 1.15 in an attempt to produce mucic acid, but only a trace amount of it could be obtained.

ANALYTICAL RESULTS OF CORN SILK

CONSTITUENT	PER 100 PARTS OF AIR-DRIED SAMPLE	PER 100 PARTS OF ANHYDROUS SAMPLE
Moisture	12.65	-
Crude fat	1.92	2.20
Crude protein	16.63	19.04
Soluble nitrogen-free compounds	45.50	52.09
Crude fiber	17.70	20.26
Crude ash	5.60	6.41
Total nitrogen	2.83	3.24
Protein nitrogen	2.25	2.58

Nonprotein nitrogen	0.58	0.66
Pentosan	15.60	17.86
Methylpentosan	Trace amount	Trace amount
Reducing sugars	1.90	2.17
Nonreducing sugars	Trace amount	Trace amount
Galactan	"	"
Total acids (in terms of sulfuric acid)	0.49	0.56

B. INORGANIC COMPONENTS

A 30 g portion of the sample was placed on a platinum dish, ignited, and incinerated at low temperature, and treated with aqua regia. Silicic acid was eliminated by normal method, and inorganic constituents were quantitatively determined. For the determination of chlorine, the above sample was infused in distilled water, and was subjected to titration with N/20 silver nitrate solution.

ANALYTICAL RESULTS OF CORN SILK

CONSTITUENTS	PER 100 PARTS OF AIR-DRIED SAMPLE	PER 100 PARTS OF DRIED SAMPLE
Moisture	12.65	-
Ash	5.60	6.41
Hydrochloric acid soluble silicic acid (SiO_2)	0.15	0.17
Iron oxide and Al_2O_3	0.33	0.33
Lime (CaO)	00.61	0.70
MgO	0.56	0.64
Potassium (K_2O)	1.67	1.91
Soda (Na_2O)	0.16	0.18
Phosphoric acid (P_2O_5)	0.56	0.64
Sulfuric acid (SO_3)	0.03	0.03
Chlorine (Cl)	0.30	0.34

5. PRODUCTS OF HYDROLYSIS

A 1 kg portion of sample was placed in a porcelain jar, and 4% sulfuric acid was added. The mixture was heated in water bath for approximately 3 hours, thereby subjecting it to hydrolysis. Then, the sulfuric acid solution was eliminated by decantation, and the residue was compressed. The liquid from the residue was combined with the sulfuric acid solution, and, after filtration, calcium carbonate was added, thereby neutralizing the sulfuric acid. The resultant precipitate was filtered out, and the filtrate was distilled in vacuum, thereby reducing its quantity. After cooling, 60% ethanol was added, and impurities eliminated. The filtrate was distilled, thereby reducing its quantity, and 80% ethanol was added, and impurities eliminated. The filtrate was distilled, thereby recovering the ethanol, and permitted to evaporate, thereby rendering a syrup-like form. Impurities were eliminated several times by means of absolute ethanol. As a result, a transparent syrup was obtained. Then, the product was discolored with a small amount of water and bone charcoal, and purified with absolute ethanol, which yielded approximately 117 g of syrup. The product was stored in a sulfuric acid drier, and subjected to the following tests.

A. QUALITATIVE ANALYSIS

The syrup was dissolved in water for qualitative tests, and the following results were obtained.

- a. Highly sweet.
- B. Actively reduces Fehling solutions.
- c. Molisch's reaction, positive.
- d. Bramis' reaction, negative.
- f. Pinoff's reaction, negative.
- g. The formation of methyl phenylosazone was attempted by Neuberg's method, but the result was negative.
- h. The attempt to produce phenyl and methylphenyl hydrazones failed.
- i. The formation of phenyl asazone was attempted, and a large amount of it was obtained.
- j. Sixty cc of nitric acid with a specific gravity of 1.15 was added to 5 g of syrup. The mixture was permitted to evaporate over water bath, thereby reducing the amount to approximately 20 cc. Then, the contents were filtered, and permitted to stand for 24 hours. Subsequently, 1 cc of water was added and the mixture, stirred and left standing, which provided a large amount of needle crystals. After separating and drying the crystals, the melting point was measured. M.P., 212-5 - 213.5°C. The material was soluble in hot water and ammonia, but sparingly soluble in alcohol and ether. The melting point of the crystals was extremely close to that of mucic acid (Schleimsaure). The melting point of the mucic acid is 225°C according to Skaup, 212-215°C according to Tollens, Lippmann, and Kiliani and Scheidler (14), and 213-214°C according to Abderhalden (15). Thus, the crystals was apparently mucic acid, and the syrup is assumed to contain galactose.
- k. Thirty cc of nitric acid with a specific gravity of 1.15 was added to 5 g of syrup, and the mixture was permitted to evaporate over water bath, thereby obtaining a yellowish syrup. A small amount of water was added, and the mixture was permitted to evaporate, which provided a syrup. Then, it was dissolved in a small amount of water, and the solution was filtered. The filtrate was combined with potassium carbonate, thereby making it basic, and several drops of glacial acetic acid was added, thereby acidifying it. After left standing, it was subjected to microscopic examination, which revealed needle crystals of potassium saccharate. The crystals were separated and recrystallized from warm water, and, after drying, heated in a capillary, which increased the volume due to decomposition at 194.3°C. The addition of a silver nitrate solution to an aqueous solution of the crystals immediately produced a precipitation of silver salt, which was then filtered out and dried in dark place. It was found that the material contained silver at a rate of 50.4%, which is extremely close to the theoretical value of 50.94% $\left[\text{AgOOC}-(\text{CHOH})_4-\text{COOAg} \right]$. Therefore, the crystals obtained from the acetic acid acidified solution was potassium saccharate, and the crystals are sparingly soluble in cold water but readily soluble in warm water. When ammonia was added to its aqueous solution, thereby making the solution alkaline, and a lime chloride solution was added to the mixture, a white precipitation of lime saccharate was formed.
- l. Hydrochloric acid with a specific gravity of 1.06 was added to 5 g of syrup, in order to test the formation of furfural and methylfurfural according to the procedures described by Ellet and Tollens (13), and Oshima and Kondo (13), respectively. The reaction for the former was clearly positive. When phloroglucin was added, a large amount of furfural phloroglucinid precipitated. However, no methylfurfural was formed.

- m. A 0.5 g portion of the syrup was transferred to a test tube, and dissolved in 0.1 cc of water, and after 0.1 cc of bromine was added, the mixture was shaken and left standing for 48 hours. Then, the test tube was heated, thereby eliminating the bromine, and the remaining portion was transferred to an evaporating dish. While heating, a large amount of cadmium carbonate was added and evaporation was continued. Subsequently, a small amount of hot water was added, and, after filtering and cooling, ethanol equal in quantity to one half of the contents was added. As a result, a large amount of precipitate was formed. Microscopic examination revealed needle crystals with rhomboidal angles at the ends. They were found to be crystals of the cadmium salt of xylonate bromate (cadmium xylonate).

B. SEPARATION OF OSAZONE

When the phenylosazone obtained in test (i) was examined in the microscope, a large amount of glucosazone was observed. In order to eliminate glucose in the syrup, the syrup was dissolved in water and sterilized, and combined with *saccharomyces cereviceae*. The mixture was fermented for 7 days in a thermostat at 40°C. Upon completion of fermentation, calcium carbonate was added to the fermented solution, thereby neutralizing the solution, the filtrate was permitted to evaporate, thereby reducing its quantity, 95% ethanol was added several times, and the ethanol solution was permitted to evaporate, which provided a syrup.

A mixture of 1g of syrup, 0.5 g of phenylhydrazine, and 0.5 g of water was stirred, which produced phenylhydrazone. The product was permitted to evaporate, thereby reducing its quantity, and, after colling, ether was added, thereby eliminating excess phenylhydrazine. The ether was eliminated, and the remainder was heated and stirred, but no hydrazone was formed. Then, 200 cc of water and a small amount of glacial acetic acid were added to this solution, heated in a water bath, and cooled, as a result of which a large amount of phenylosazone was obtained. The osazone was filtered out and examined in the microscope, which revealed aggregations of yellow needle crystals. The osazone was separated into a portion sparingly soluble in hot water and a portion readily soluble in hot water, and each portion was recrystallized with 60% ethanol, which produced the same shape of crystals.

The recrystallized osazone was filtered and dehydrated, and, after drying in a sulfuric acid drier, its melting point was determined. The portion sparingly soluble in hot water had an m.p. of 160-162°C, and the readily soluble portion, 154-155°C. Both portions were soluble in methyl alcohol, ether, and acetone. The latter was recrystallized from alcohol and pyridine, and the crystals then had a lower melting point, 157-158°C. From these experimental results, these osazones were found to be xylose phenylosazone. The melting point of xylose phenylosazone is said to be 152-155°C according to Hebert, but 155°C according to Bauer, 158°C according to Stone and Test, 160°C according to Koch, and 161°C according to Allen and Tollens, or Tollens (16). Some gave lower melting points, but the variation can be attributed to impurities.

6. SUMMARY

The above experimental results can be summarized as follows:

1. A greater proportion of corn silk comprises nitrogen free compounds.
2. Phytosterol is one of the components of corn silk, and can be separated from an ether infusion.

3. Corn silk contains approximately 2% of reducing sugars, and a great proportion of it is glucose. The presence of glucose was verified in the form of glucose phenylosazone, extracted from an ethanol infusion.
4. The carbohydrates contained in corn silk comprises glucose, pentoza, galactane, etc.
5. The main constituent of pentoza is xylane.
6. The presence of xylane was confirmed in the form of cadmium xylose salt and xylose phenylosazone from the product of hydrolysis.
7. The presence of galactane was confirmed by the formation of mucic acid from the product of hydrolysis.
8. A small amount of organic acids are contained in corn silk.
9. Principal inorganic constituents include potassium salt, and a part of it was separated from the ethanol infusion in the form of potassium chloride.

The author is deeply grateful to Dr. T. Nishino and Dr. M. Tanaka for the analyses of ordinary components and collection of the samples.

REFERENCES

2. Miake, T.: Sapporo Norin Gakkaiho, Vol. 13, p. 19, 1921.

玉蜀黍雌蕊の無窒素成分に就て (第一報)

技 師 突 永 一 枝

目 次

- | | |
|------------|------------|
| 1. 緒 言 | 2. 試 料 調 製 |
| 3. 定 性 試 験 | 4. 定 量 分 析 |
| 5. 加水分解生産物 | 6. 結 要 |

1 緒 言

玉蜀黍は禾本科に属する作物の1種であつて學名を *Zea mays* L. と稱し、世界に於ける重要なる作物である。其の雌蕊 (Corn silk, style or stigma) は長さ空管内に粘性物質を含有し、其の先端は2分して居る。corn silk の長さは6-12吋であつて其の周囲に短き毛を有し、受粉 (Pollination) 後は漸次乾燥萎凋するものである。玉蜀黍 (Corn) の成分につきては研究の發表せられたものが相當多いが、雌蕊 (Corn silk) に就いては研究せられたものが非常に少い。玉蜀黍の花粉の成分については1918年に Dutcher Collotzi 兩氏(1) が可溶性グキタミンに富む事を報告し、フキトステリン (Phytosterin) の存在に就いては1921年に三宅捷氏(2) が發表して居る。其の他同氏(3) は花粉の酵素作用につきて研究し、酵素 Amylase, Sucrase, Pepsin, Tripsin, Kymase 及 Peroxydase の存在は認めたが、Maltase, Glycose Emulsin, Urease, Oxydase, Katalase 及 Elepsin の作用は認めなかつたと報告して居る。又同氏は玉蜀黍10品種につきて水分及灰分の含量並に Diastase の作用を比較して居る。

其の他 Fred 及 Peterson 兩氏(4) は玉蜀黍の心 (Corn cobs) につきて研究し、加水分解によりて約30-40%の Xylose を得、之れに *Lactobacillus pentosecticus* n. sp. を作用せしめて乳酸を製造し得べしと報告して居る。更に Mouroc 氏(5) は corn cobs の粘性物を酸分解して Furfurol を得、之れに硫化アルカリ又は Phenol を作用せしめて染料又は染料用の樹脂様物質を得たと報告して居る。其の他玉蜀黍の幹 (corn stalks) につきては Kerr 及 Stewart 兩氏(6) 並に Perold 氏(7) が蔗糖の存在することを認めて其の利用的価値につきて報告して居る。玉蜀黍雌蕊 (corn silk) の化学的性質につきては研究報告の發表せられたものが僅少であるが、是等の利用法については種々の記載がある。

我が國に於ては古くより種痘料として民間に應用せられ、醫者も時に之を用ゐて居り、現今

尚ほ應用せらるるものであつて、ピスチン (Pistin) の如きは是等を原料としたものである。又米國藥局法(8) によれば玉蜀黍の雌蕊は "Zea", *Maidis stigma* 又は corn silk として記載せられて居る。而して Radmaker 及 Fischer 兩氏(9) は乾燥雌蕊中には2.25%の maizenic acid を含有し、此の物質は水、酒精及エーテルには可溶性であるが、ベンジンには不溶性であつて、其の外に油脂、樹脂 (resin), クロロフィル (chlorophyll), 砂糖、澱粉、アルブミノイド (albuminoids), フロバフェン (phlobaphene), 鹽類 (salt), セルローズ (cellulose) 及水を含むして居ると報告して居る。而して米國に於ては玉蜀黍雌蕊は強き利尿劑であつて腎臓病並に膀胱炎及尿結石に有效であると稱して居る。其の他淋病 (gonorrhoea) にも使用せられて居る。亦 Landrent 氏(10) の如きは有效なる利尿劑であるのみならず水腫性心臓病に對し強心作用を與へると稱して居る。我が國に於ても本間博士、白鳥博士等も是等の事實を證明して居る。

然るに是等に関する化學成分につきては發表せられたもの僅少なを以て、余は滿洲産玉蜀黍雌蕊の化學成分研究を試み、漸く其の1部を取纏めたるにつきて滿洲産玉蜀黍雌蕊の無窒素化合物に就てと題して茲に報告する次第である。

2 試 料 調 製

8月上旬より9月上旬に於て滿鐵農事試験場試作の圃場より玉蜀黍雌蕊を採集し、之を乾燥して粉碎し、罎中に密封貯藏して研究試料とした。(品種一在來種)

3 定 性 試 験

A. エーテル浸出物よりフキトステリン (phytosterin) の分離

フキトステリンの分離は Boemer's method¹¹⁾ によれるものであつて、前記の試料100gをエーテルにて浸出し、エーテルを除去したる後苛性加里酒精液 (苛性加里30gを95%酒精1Lに溶解せるもの) 50ccを加へて重湯煎上に還流冷却器を附して煮沸し、鹼化を行ひたる後酒精を蒸餾して殘渣に水30ccを加へ、沈澱を溶解せしめて分液漏斗に移し、エーテルを加へて振盪し、エーテル可溶性物質を分離してエーテルを除去し、鹼化せざりし脂肪は更に前記同様に處理して鹼化を行ひ、再び分液漏斗に移してエーテル可溶性物質を分離し、エーテルを除去せるに蠟質物と共に無色針狀の結晶を得たるを以て、是れを精製して不純物を除去し、更に酒精及竹炭を用ゐて脱色し、無水酒精より再結晶せしめたるに無色板狀の結晶を得た。依つて該結晶につき定性試験を行へるに次の結果を得た。

- a. 該結晶は酒精、エーテル又はクロロホルムに可溶性。
 - b. エーテル溶液より結晶せしめたるものは絹絲狀の針狀結晶であるが、酒精溶液より結晶せしめたるものは無色斜方晶系の板狀結晶である。
 - c. 熔融點を測定せるに 137.95° である。
 - d. 前記の結晶を氷醋酸と共に蒸發皿中に煮沸せる後平湯煎上にて蒸發乾固し、之れに無水酒精を加へて加温溶解せしめ、靜に冷却析出せしめたる結晶は熔融點 131° である。
 - e. 載物硝子上に前記の結晶を取り硫酸（濃硫酸5と水1との混液）を加へて檢鏡するに深赤紫色を呈し、之に沃度沃度加里を加ふるときは紫綠色又は赤色を呈す。
 - f. 前記の結晶をクロロホルムに溶解したる後、比重176の硫酸を滴加するときは上部のクロロホルム層は紫色を呈し、硫酸層は反射光線に對し綠色の螢光を放つたが、透射光線に對しては紅色を呈す。
 - g. 前記の結晶を無水醋酸及クロロホルムの混和液に溶解し、濃硫酸1滴を加へたるに蒼灰色を呈し、數時間後には更に青綠色を呈す。
 - h. 前記の結晶を濃硫酸にて濕し、之を低温にて蒸發せるに黃色を呈し、アンモニアを加ふれば赤色を呈す。
 - i. 前記の結晶を濃硫酸に濕し、之に鹽化第2鐵液を加へて低温にて蒸發するときは紫色を呈す。
 - j. 前記の結晶を試験管に入れ昇華せしめるに光澤ある油滴狀を呈す。
- 以上の結果を綜合するに前記のエーテル浸出物より得たる不純化物質は phytosterin ($C_{27}H_{46}O$) なることを確實である。其の他エーテル浸出物中には有機酸の存在することを認めたが、其の得量僅少なりしたため其の性質を詳にすることを得なかつた。

B. 酒 精 浸 出 物

1. 酒精浸出物より無機物質の分離

風乾雌蕊1kgを内容5Lのフラスコに入れて無水酒精2.5Lを加へ回流冷却器を附して浸し、酒精浸出液を蒸餾したる後3回同様に處理し、酒精液は真空蒸餾によりて酒精を回收し、殘渣は蒸發して舍利別となし、之れを硫酸乾燥器中に乾燥せり、茲に得たる舍利別は約8gなりしが、乾燥器中にて漸次結晶の析出増加するを認めた。依つて該結晶を分離せんがために無水酒精を以て處理せるに該結晶は酒精に溶解せざりしを以て、之を蒸餾せるに乾燥後約1gの結晶を得た。結晶は少量の水に溶解して數回再結晶を行ひたるに、0.6gの白色結晶を得た。該結晶を檢鏡せるに白色の結晶が骰子狀の結晶であつて、其の性質をみるも同

解性に非ず。而して該結晶は酒精及醋酸に不溶性なるも、水には極めて可溶性であつた。該結晶に就いて行へる定性試験の結果は次の如くである。

- a. 白金板上に熱する時は結晶水を失ふて白色の粉末となり、無機物質なることを確めた。
- b. 水溶液に硝酸銀液を加ふるに白色の沈澱を生じ、鹽素の存在すること明である。
- c. 水溶液に鹽酸を加へて加熱し、之れに鹽化バリウムの溶液を加ふるも、硫酸バリウムの沈澱を生ぜず。
- d. 水溶液にフェーリング液を加ふるに中性である。
- e. 水溶液に消石灰の溶液を加へて蒸發せるに、細き光澤ある結晶を得たるを以て檢鏡せるに無色柱狀の結晶であつて、平湯煎後加里の結晶に極めて近似である。
- f. 水溶液を蒸發して灼熱し、鹽化白金液を加へて蒸發檢鏡せるに、鹽化白金加里 (K_2PtCl_6) の結晶に極めて近似であつて、80%酒精に溶解しない。
- g. 前記の結晶を灼熱したる後0.1gを水に溶解して25.0ccとなし、其の2.5ccを取りて鹽素及加里の定量をしたが次の結果を得た。

實 驗 數		右計算數
鹽化白金加里	0.0319 g	加 里 0.0051 g
N/100硝酸銀液	2.7 cc	鹽 素 0.0047 g

更に鹽化加里100に對する加里及鹽素の比を見たるに次の如くである。

計 算 數		理論數
加 里	52.04 %	52.44 %
鹽 素	47.96 %	47.56 %

以上の結果を綜合するに前記の等結晶系の骰子狀白色結晶は鹽化加里である。

2. 酒精浸出液より糖類の分離

前記の結晶を分離したる酒精液は平湯煎上にて酒精を除去し、低温にて舍利別となし、更に本法を反覆して不純物を除去し約7gの舍利別を得た。舍利別の得量は第1回7g、第2回6g、第3回8gであつて、平均7gを得た。茲に得た舍利別について定性試験を行ふたが、其の結果は次の如くである。

- a. 水に可溶性であつて、甘味あり。
- b. 水溶液はフェーリング液 (Fehling solution) を還元す。
- c. 鹽酸にて加水分解を行へるに還元力の増加は痕跡である。
- d. モーリツシュ氏反應 (Molisch's reaction) 陽性。
- e. セリワソフ氏反應 (Seliwanoff's reaction) 陰性。

- f. ピノッフ氏反応 (Pinoff's reaction) 陰性。
- g. ノイベルヒ氏反応 (Neuberg's reaction) 陰性。
- h. サツカリツク酸 (Saccharic acid) 加里の生成を試みたるに多量を得た。
- i. ミューシツク酸 (mucic acid) の生成を試みたるに陰性であつた。
- j. 鹽酸で加水分解してペントースの反應 (Pentose reaction) を試みたるに陰性。
- k. フェニール、ヒドラゾン (phenylhydrazone) の生成を試みたるに陰性。
- l. 合判別 2 g 鹽酸フェニールヒドラジン 2 g、醋酸酐 3 g、水 2.0cc を加へて重湯煎中に加熱せるに、多量のオサゾン (Osazone) を生成した。該オサゾンを檢鏡するにグルコオサゾン (glucosazone) 近似の針狀結晶であつた。該オサゾンを濾別して熱水で洗滌せるに一部は溶解し、洗滌液の冷却と共に再沈澱したるが、前記オサゾンの大部分は熱水に不溶性であつた。熱水不溶性のオサゾンは黄色の針狀結晶であつて星狀又は松葉狀に集合し、水、メチルアルコール及エーテルには難溶性であつたが、エチルアルコール及アセトンには極めて可溶性であつた、是等の結晶を2分して 60% 酒精及アセトンにてそれぞれ再結晶を行ひ、分節乾燥せる後熔融點を測定せるに 202-204°C であつた。熱水に溶解せるオサゾンは濾別して前記同様處理せるに其の形狀及性質は前者と同様であつたが熔融點は 200-202°C であつた。

上記の結果から見ると前者は Fischer 氏並に Tiemann 及 Kees 兩氏 (11) の報告せるグルコオサゾンの熔融點と近似であつて、其の形狀及性質も是等と一致して居る。而して後者の熔融點低きは尚ほ不純物を含有せるためで前者と同一のものらしいが、其の量僅少なりしたため再檢定を行ふことを得なかつた。

是等の結果を綜合するに合判別中に葡萄糖を含有することは確實である。

4 定 量 分 析

A. 有 機 成 分

前記の試料につき常法により普通成分の定量をなしたが、特殊成分の定量については次の如く處理した。

1. ペントーザン及メチルペントーザン (Pentosan and methylpentosan)。

是等の定量に當りては試料 0.5 g につき Ellet 及 Tollens 兩氏 (12) 並に Oshima 及 Kondo 兩氏 (13) の方法を採用し、Pentosan の計算に當りては Tollens 及 Krole 兩氏の Table を採用した。

2. 還元糖及非還元糖。

還元糖及非還元糖の定量に際しては試料 1 g を 80% 酒精と共にフラスコに入れ、蒸流液

器を附して重湯煎上に温浸濾別すること3回に及び、更に殘液を濾紙上に傾瀉して前記酒精にて洗ひ、濾液は合して真空蒸留によりて酒精を除去し、不純物を濾別したる後濾液を 250.0cc となし、其の一部を取りて還元糖を定量し、他の一部は鹽酸を加へて 2% とし 20 分間湯煎上に煮沸したる後之を中和して 25.0cc となし其の一部を採りて還元糖と同様に青酸加里法によりて定量した。

3. ガラクトン (galactan)

試料 5 g を比重 1.15 の硝酸にて處理し粘液酸 (mucic acid) の生成を試みたが痕跡であつた。

玉蜀黍雌蕊分析成績

成 分	風乾物100分中	無水物100分中
水 分	12.65	—
粗脂肪	1.92	2.20
粗蛋白質	16.63	19.04
可溶性無機素物	45.50	52.09
粗纖維	17.70	20.26
粗灰分	5.60	6.41
全窒素	2.83	3.24
蛋白質窒素	2.25	2.58
非蛋白質窒素	0.58	0.66
ペントーザン	15.60	17.86
メチルペントーザン	痕跡	痕跡
還元糖	1.90	2.17
非還元糖	痕跡	痕跡
ガラクトン	”	”
總 酸 (硫酸として)	0.49	0.56

B. 無 機 成 分

前記の試料 30 g を白金皿に入れ、低温にて灼熱灰化したる後王水にて處理し、常法によりて硅酸を分離し、無機成分を定量した。鹽素は前記の試料を蒸溜水にて浸出し、20 分の 1 規定硝酸銀液を以て滴定した。

玉蜀黍雌蕊分析成績

成 分	風乾物100分中	乾物100分中
水 分	12.65	—
灰 分	5.60	6.41
硫酸可溶性酸 (SiO ₂)	0.15	0.17
酸化鐵及礬土 (Fe ₂ O ₃ +Al ₂ O ₃)	0.33	0.38

石灰 (CaO)	0.61	0.70
苦土 (MgO)	0.56	0.64
加里 (K ₂ O)	1.67	1.91
曹達 (Na ₂ O)	0.16	0.18
磷酸 (P ₂ O ₅)	0.56	0.64
硫酸 (SO ₃)	0.03	0.03
鹽素 (Cl)	0.30	0.34

5 加水分解生産物

前記の試料 1kg を陶製の壺に入れ、4% の硫酸を加へて約 3 時間重湯煎中に加熱し、加水分解を行ひたる後硫酸液を傾瀉し、殘渣は壓搾して流液を前者と合し、一度濾過したる後炭酸石灰を加へて硫酸を中和し、此所に生じたる沈澱を濾別し、濾液は真空蒸溜を行ひて少量となし、冷却後 60% 酒精を加へて不純物を除去し、更に濾液は蒸溜して少量となし 80% 酒精を加へて不純物を除去し、濾液は蒸溜して酒精を回収し、更に蒸發して舍利別状となし無水酒精を加へて不純物を除去すること數回にて透明なる舍利別を得たるを以て、之に少量の水と竹炭を加へて脱色し、無水酒精にて精製し約 117 g の舍利別を得たるを以てこれを硫酸乾燥器中に貯藏し次の試験に供用した。

A. 定性試験

前記の舍利別を水に溶解し定性試験を行へるに其の結果は次の如くであつた。

- 甘味強し。
- フツリング液 (Fehling solutions) を強く還元す。
- モーリッシュ氏反應 (Molisch's reaction) 陽性。
- ブラミス氏反應 (Bramis' reaction) 陽性。
- セリワソフ氏反應 (Seliwanoff's reaction) 陰性。
- ピノッフ氏反應 (Pinoff's reaction) 陰性。
- ノイベルヒ氏法 (Neuberg's method) によりメチール、フェニールオサゾン (Methyl-phenylosazone) の生成を試みたるに陰性。
- フェニール及メチールフェニールハイドラゾン (hydrazone) の生成を試みたるに陰性。
- フェニールオサゾン (phenyl-osazone) の生成を試みたるに多量のオサゾンを生成せり。
- 舍利別 5 g に比重 1.15 の硝酸 60cc を加へて重湯煎上に蒸發し約 20cc に減少せしめたる後濾過し、24 時間放置したる後 1cc の水を加へ攪拌放置したるに多量の針狀結晶を生じた。依つて該結晶を分離乾燥せる後結晶點を測定せるに 212.5-213.5°C であつて、熱水及アンモ

ニア水には可溶性であつたが、アルコール及エーテルには難溶性であつた。而して該結晶の熔融點は粘液酸 (mucic acid, Schleimsaure) のそれと極めて近似であつた。粘液酸の熔融點は Skaup 氏によれば 225°C であるが、Tollens 氏、Lippmann 氏、Kiliani 及 Scheibler 兩氏 (14) によれば 212-215°C である。亦 Abderhalden 氏 (15) によれば 213-214°C である。従つて該結晶は粘液酸であつて、舍利別中にはガラクトース (galactose) の存在するものと認めらるゝのである。

k. 舍利別 5 g に比重 1.15 の硝酸 30cc を加へ重湯煎上に蒸發して黄色の舍利別とし、更に少量の水を加へて蒸發し、舍利別となしたる後少量の水に溶解して濾過し、濾液は炭酸加里を加へて鹽基性となし、之に數滴の水醋酸を加へて酸性となし、放置せる後檢鏡せるに糖酸カリウム (Zuchersaures Kalium) の針狀結晶を認めた。依つて該結晶を分離し温湯より再結晶し、乾燥後も細管中に熱すれば 194.3°C で分解し容積の膨大するを認めた。該結晶の水溶液に硝酸銀液を加ふれば直ちに銀鹽の沈澱を生じたるを以て之を濾別し、暗所で乾燥し銀の含量を見たるに 50.4% であつて、理論數 50.94% [$\text{AgOOC}-(\text{CHOH})_4-\text{COOAg}$] に極めて近似であつた。従つて前記の醋酸酸性液より得たる結晶は糖酸カリウムであつて、該結晶は冷水には難溶性であるが温水には容易に溶解し、其の水溶液にアンモニアを加へてアルカリ性となし、之に鹽化石灰液を加ふれば白色の糖酸石灰の沈澱を生ず。

l. 舍利別 5 g に比重 1.06 の鹽酸を加へ Ellet 及 Tollens 兩氏 (13) の方法によりフルフロール (Furfural), 大島及近藤兩氏 (13) の方法によりメチールフルフロール (Methyl-furfural) の生成を検せるに前者の反應は明であつて、フロログルチン (Phloroglucin) を加ふれば多量のフルフロールフロログルシッド (Furfural-phloroglucid) の沈澱を生じたが、メチールフルフロールの生成を認めなかつた。

m. 前記の舍利別 0.5 g を試験管に採り、之を 0.1cc の水に溶解し、臭素 0.1cc を加へて振盪し、48 時間放置したる後、試験管を加熱して臭素を驅逐して蒸發皿に移し、加熱しつつ過剰の炭酸カドミウムを加へて蒸發し、少量の熱水を加へて濾過冷却後約半量の酒精を加へたるに多量の沈澱を生じたるを以て、該沈澱を檢鏡せるに先端に稜角を有する針狀結晶であつて、臭化キシロースのカドミウム鹽 (Cadmium Xylonate) の結晶なることを認めた。

B. オサゾン (Osazone) の分離

前記 i. により得たるフェニールオサゾン (phenylosazone) を檢鏡せるに多量のグルコオサゾン (glucoosazone) の存在するを認めたるを以て、舍利別中のグリエコース (glucose) を除去するために前記の舍利別を水に溶解して殺菌し、之れに *Saccharomyces cereviceae* を

加へて40°C恒温器内に7日間酸酵せしめたるに、酸酵終れるを以て酸酵液に炭酸石灰を加へて中和し、濾液は蒸發して少量となし數回95%酒精を加へて精製し、酒精液は蒸發して舍利別となした。

前記の舍利別1gに0.5gのフェニールヒドラジン (phenylhydrazine) 及0.5gの水を加へて攪拌せるにフェニールヒドラゾン (phenylhydrazone) の生成を認めざりしを以て、更に蒸發して少量となし、冷却後エーテルを加へて過剰のフェニールヒドラジンを除去し、エーテルを蒸發して加熱攪拌したがヒドラゾン (Hydrazone) の生成を認めなかつた。依つて該液に200ccの水及少量の水醋酸を加へて煮沸中に加熱せるに冷却後多量のフェニールオサゾン (phenylosazone) を生成した。依つて該オサゾン (Osazone) を識別し檢鏡せるに黄色の針狀結晶の集合せるを認めた。而して該オサゾンは熱水に難溶性のものと易溶性のものに分離し、それぞれ60%酒精にて再結晶を行へるに何れも同一の形狀を有して居るのが多かつた。

再結晶せるオサゾンは濾別して脱水し、硫酸乾燥器中に乾燥せる後熔融點を測定したが熱水に難溶性のものは160-162°Cで、易溶性のものは154-155°Cであつた。而して是等のオサゾンは何れもメチールアルコール (Methylalcohol), エーテル (Ether), アセトン (Aceton) に可溶性であつた。依つて後者は更にアルコール及ピリヂン (Pyridin) を加へて再結晶せるに熔融點157-158°Cとなつた。是等の結果から該オサゾンは何れもキシロースフェニールオサゾン (Xylose-phenylosazane) なることを察知した。キシロースフェニールオサゾンの熔融點は Hebbert 氏によれば152-155°Cであるが Bauer 氏によれば155°Cであつて Stone 及 Test 兩氏によれば158°C, Koch 氏によれば160°, Allen 及 Tollens 兩氏並に Tollens によれば161°C(16)であつて、熔融點の低きものあるは尙ほ不純物を含有する結果だと思ふ。

6 摘 要

以上の結果を綜合すると次の如くである。

1. 玉蜀黍雄蕊の大部分は無窒素化合物よりなる。
2. フェイストステロールは玉蜀黍雄蕊の一成分であつて、エーテル抽出物より之を分離せり。
3. 玉蜀黍雄蕊中には約2%の還元糖を含有し、其の大部分は葡萄糖であつて葡萄糖の存在は酒精抽出物よりグリニコース、フェニールオサゾンとして證明せり。
4. 玉蜀黍雄蕊中の炭水化物は主として葡萄糖、ペントーザン、ガラクトサン等よりなる。
5. ペントーザンは主としてキシランよりなる。

6. キシランの存在は加水分解生産物よりキシロースのカドウム鹽及キシロースフェニールオサゾンとして證明せり。
7. ガラオタンの存在は加水分解生産物より粘液酸の生成により之を證せり。
8. 玉蜀黍雄蕊中には少量の有機酸を含有す。
9. 無機物質中の主要なるものは加里鹽であつて其の一部は酒精抽出物中より鹽化加里として分離せり。

本研究をなすに當り試料の採集並に普通成分の分析は西野利雄及田中正吉兩氏の助力を得たことを兩氏に感謝す。

引 用 文 献

- 1) Dutcher and Collotzi; J. Am. 36, 547-550 (1918).
- 2) 三宅捷, 札幌農學院學報 13, 19, (1921).
- 3) " " 11, 24, (1921).
- 4) Fred and Peterson; J. Ind. & Eng. Chem. 13, 211-213, (1921).
- 5) Mouroe; " 13, 133-135, (1921).
- 6) Kerr and Stewart; American industries, February, 16-51, (1910); Burr-Davy; Maize, 693, (1914).
- 7) Perold; Agricultural Journal of the Union of South Africa, 1911, May.
- 8) Wood, Remington and Sadtler; U. S. Pharmacopoeia, 1: Burr-Davy; Maize, 802, (1914).
- 9) Rademaker and Fischer; Am. J. of Pharm. 369 (1886).
- 10) Burr-Davy; Maize, 802, (1914).
- 11) Lippman; Die Chemie der Zuckerarten, I, 1904, p. 535. Ber. 17, 579; 18, 1660; 20, 827; 21, 987.
- 12) Ellet and Tollens; J. fur Landwirtschaft, 53, 110, (1905); Ber. 33, 492-499 (1906).
- 13) Oshima and Kondo; Journal of the Tokyo chemical Society, 39, No. 3, 135-198, (1918).
- 14) Lippmann; Die Chemie der Zuckerarten, I, 720, (1904).
- 15) Abderhalden; Biochemisches Handlexikon, II, 507, (1911).
- 16) Lippmann; Die Chemie der Zuckerarten, I, 140, (1904).

FROM THE DEPARTMENT OF ANATOMY, HAHNEMANN MEDICAL COLLEGE AND
HOSPITAL PHILADELPHIA, U.S.A. HEAD OF THE DEPARTMENT :
PROFESSOR TH. W. PHILLIPS

OBSERVATIONS OF INFLUENCE OF CORN-SILK EXTRACT (STIGMATA MAYDIS ZEAE) ON BLOOD PRESSURE IN HYPERTENSIVE RATS

BY

H. WASTL, M. D.

(Received for publication 12-11-1946).

Corn-silk extract, usually as a tincture of *stigmata maydis zeae*, the fresh styles and stigmas of *zea mays* Linné (Fam. Gramineae) is used occasionally, f.i. in the alleviation of urinary distress, scanty urine and retention of urine, tenesmus after urinating, vesical catarrhs etc. BOERICKE (1) recommends a (spaced) dosage of 10-50 drops of the 10 % tincture per diem.

Very little is known about the constituents of corn-silk extract. KRAEMER (2) mentions very briefly that the dried drug contains a volatile alkaloid; two resins, about 5.5%; a crystalline principle, maizenic acid, about 1.25%; fixed oils, about 5.25%; sugars; ash, about 12%. SOLIS-COHEN (3), also mentions corn-silk extract in a few words, thinking that the maizenic acid is its main acting faction.

The incentive to briefly study influences of injections of corn-silk extract on the blood pressure levels of experimentally hypertensive rats originated in a few casual observations of some general practitioners who noted (*) that now and then patients, treated temporarily with tinctures of *stigmata maydis zeae* and being at the same time also cases of hypertension showed, in a very few instances, a certain mild reduction of their blood pressure levels, while under corn-silk medication. This was, of course, not an exclusive medication, but only a part of the prescribed medicines and any observed temporary reduction of blood pressure levels could not be ascribed quite obviously to this part offhand, without any experimental or clinical background whatsoever existent at all.

(*) Related to the author by word of mouth.

Since the reason and manifold causes for the development of hypertension are to date still very obscure (4), it did not seem an entire waste of time to investigate briefly the possibility of effects of corn-silk extract on normotension and experimentally induced hypertension in rats, using an intraperitoneally injected test-dose of 0.1 mgm/kgm. after having explored in a series of preliminary experiments lower and higher dosages of the substance.

METHOD

Adult male and female rats (White Wistar rats and a piebald strain, all about the same age) were made permanently hypertensive by looping a stout cotton thread in a figure 8 over the poles of both kidneys, a method described by GROLLMAN and HARRISON (5). The normal blood pressure of the animals was studied for weeks prior to the operation; it is as a rule a very steady constant value, at a level peculiar individually to each rat. After a variable period from 1-3 months after the operation the systolic blood pressure, determined in the tails of the non-anesthetized rats by the plethymographic method of WILLIAMS et al. (6) reached its maximum and remained at this constant level (of individually variable size) for many months. Prior to measurements the rats were placed in a well ventilated, roomy box kept at $40^{\circ} \pm 1^{\circ} \text{C}$ for about 15 minutes. 4-6 readings were taken with each rat and the mean of these only slightly fluctuating readings recorded.

Corn-silk extract was injected intraperitoneally in aqueous, sterile solution, $1 \cdot 10^5$ concentration, 1 cc per 100 gms rat or 0.1 mgm/kgm. The vehicle (doubly distilled water) *per se* did not affect the blood pressures of normotensives or hypertensives, tested in control experiments. The blood pressure was tested 24 hours later, a procedure strictly similar to the one used in previous studies (7, 8, 9, 10). Pre-treatment observations were followed by 4 consecutive days of injections and then wound up by 4 consecutive days of post-treatment observations.

Hypertensive animals exhibit different degrees of hypertension, with no prediction possible. As in all previous studies, the hypertensives were divided into 3 subgroups, with low hypertension (0 to + 20 %) medium hypertension (+ 20 % to + 40 %) and high hypertension (over + 40 %) permanent increase over the respective individual normal blood pressures. The animals had excellent appetite and were fed an abundant mixed diet of table scraps, bread, milk, lettuce and fresh carrots. All together there were used 6 male and 6 female normotensives and 14 male and 14 female hypertensives.

TABLE I
Average systolic blood pressure (mmHg). Corn-silk extract. Dosage: 0.1 mgm/kgm

Degree of hypertension	Nr. of animals	Normal blood pressure		Hypertension		Injections				Cessation of Injections				Hypertension per se	
		Ave- range	Range of values	Ave- range	Range of values	Days				Range of values	Days			Ave- range	Range of values
						1	2	3	4		1	2	3		
Hypertensives															
Low 14.3 % average	12	126	110 to 138	144	110 to 158	128	124	131	133	84 to 156	142	144	144	18	0 to 26
Medium 28.2 % average	10	124	116 to 136	159	146 to 172	146	142	147	148	122 to 166	156	159	159	35	26 to 40
High 55.1 % average	6	127	120 to 134	197	186 to 210	184	180	186	187	170 to 210	195	197	197	70	60 to 88
Normotensives															
—	12	128	108 to 140	—	—	127	126	127	128	98 to 139	128	128	128	128	—

Total: 40 (20 male and 20 female animals).

Average weight of all groups: 280 gms.

Range of individual weights: 190-425 gms.

Low hypertension from 0 to +20%

Medium hypertension from -20% to +40%

High hypertension over +40%

Permanently over the individual normal systolic blood pressures prior to kidney operations

RESULTS AND COMMENTS

The values represent the average systolic blood pressures (mmHg). Only very few of the normotensives (controls) exhibited very small passing changes of blood pressure so slight and erratic as to be insignificant. The decrease (*) of systolic blood pressure during the treatment period with the hypertensives, though fairly moderate and in all 3 subgroups largest on the second day of injections is however within the range of significance. The first post-treatment day still shows a small after-effect, but the pre-treatment levels are reached again in all subgroups on the second day after cessation of injections. The tapering off of effects in all subgroups on the 3rd and 4th day of treatment indicates a certain degree of tachyphylaxis. No trace of any adverse effect whatsoever was observed in all experiments.

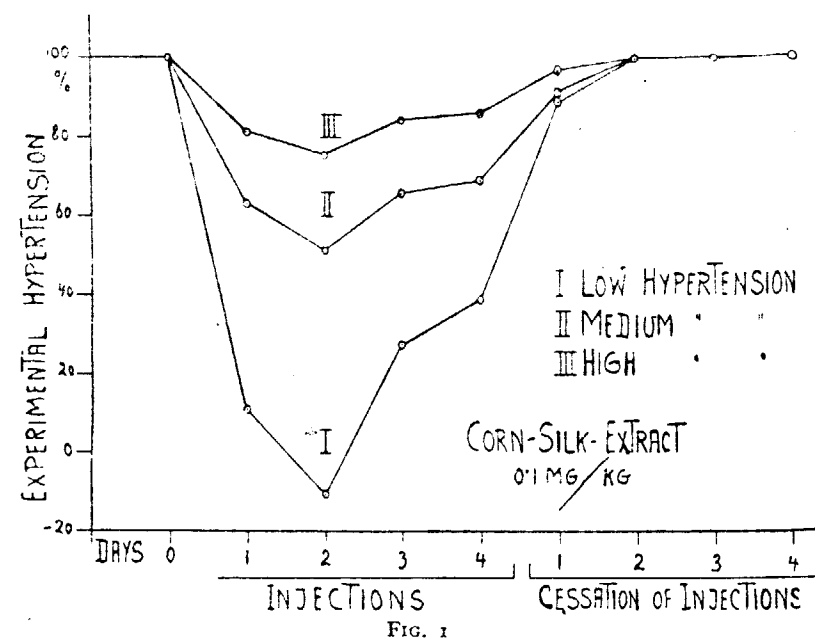


FIG. 1

(*) The values of actual decreases (mmHg) observed range between:

1	2	3	4	Days of injections.
4 to 24	10 to 34	0 to 22	0 to 30	Low hypertension.
0 to 26	6 to 38	0 to 28	0 to 18	Medium hypertens.
10 to 16	14 to 22	0 to 20	0 to 20	High hypertension.

The foremost interest of such studies with experimentally hypertensive animals lies with possible beneficial influences on hypertension *per se*, as has been discussed previously (7-10). Hypertension *per se* or the deviation from the respective normal state before hypertension was induced is taken as 100% and it is calculated what percent of it has been temporarily eliminated by the administered treatment. This representation seems to give a more graphic picture.

As has also been discussed in the previous studies (7-10) a correlation between the respective normal and morbid states—i.e. the pre-hypertensive level and the hypertensive level of the systolic blood pressures—is very desirable in such studies. For the simple reason, that the steady and constant normal blood pressures observed in rats cover a wide range between 100-142 mmHg. Each individual rat has its own pre-hypertensive level anywhere within this range and hence, when put into the morbid state of hypertension, the individual deviations can be of different magnitudes. For example, a rat with 170 mmHg hypertension can suffer under a + 28 mmHg or a + 70 mmHg increase of its systolic blood pressure, to take extreme possibilities.

Furthermore, it is advisable in such studies on experimental hypertension to group the experimental animals according to *degrees of hypertension* achieved, namely into groups of low, medium and high hypertension. Numerically, the group with high hypertension is always less numerous than the group with low hypertension, with the group with medium hypertension in between. Doubtless, the degree of any influence, expressed in absolute figures as well as in relative reckoning, depends to an appreciable extent on the degree or severity of the morbid state, which is treated.

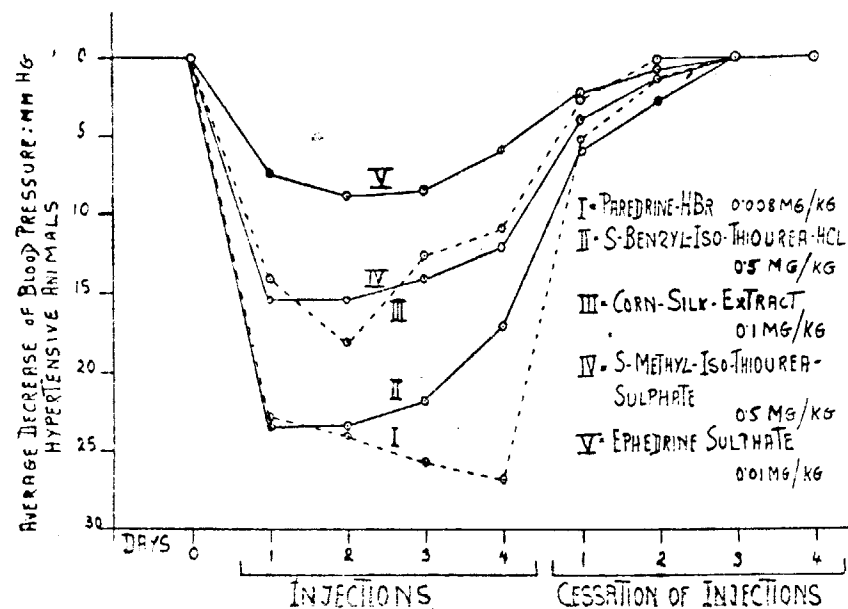
Since the experimental procedure in the present report and all previous studies (7-10) was strictly identical—re general treatment of the animals, method of blood pressure measurements (pre-treatment, 4 days of treatment, followed by 4 days of post-treatment observations), the determination of the blood pressure levels *always* 24 hours (*) after each injection (all injections intraperitoneally in sterile solutions with the same vehicle of doubly distilled water) or in 24 hours intervals after cessation of injections—a survey comparison of main trends is legitimate.

(*) Blood pressure measurements immediately after or within a few hours after the shock of an intraperitoneal injection are frequently falsified to a certain extent. The wide margin of a 24 hour interval has been chosen to avoid such falsification and to get a picture of longer range effects.

TABLE II

Average decrease of systolic blood pressure in mmHg. Hypertensive animals. All subgroups combined.

Drug	Nr of animals	Hypertension		Injections				Cessation of Injec.			
		Average	Range of values	Days							
				1	2	3	4	1	2	3	4
Paredrine-HBr 0.008 mgm/kgm	50	168	120 to 228	22.3	24.0	25.7	26.8	5.1	1.1	0	0
S-Benzyl-iso-thiourea-HCl 0.5 mgm/kgm	26	160	124 to 220	23.3	23.3	21.7	17.0	5.7	2.7	0	0
Corn-silk extract 0.1 mgm/kgm	28	167	110 to 210	14.0	18.0	12.0	10.7	2.3	0	0	0
S-Methyl-iso-thiourea-sulfate 0.5 mgm/kgm	24	160	122 to 218	15.3	15.3	14.0	12.0	3.7	1.3	0	0
Ephedrine-sulphate 0.01 mgm/kgm	50	168	122 to 220	7.3	8.7	8.3	5.7	2.0	0.7	0	0



In table II such a comparison is compounded, including 5 different substances, all of which are also effective via the oral route.

Figure 2 gives the graphic representation of the main trends.

The most favorable results as regards decreases of the levels of systolic blood pressures were achieved with pareдрine HBr and (very nearly identical) with S-Benzyl-iso-thiourea-HCl. One can remark here, that the dosage of the latter (0.5 mgm/kgm in a 1.10^5 solution) is 62.5 times higher than the dosage of the former (0.008 mgm/kgm in a 1.10^6 solution). Somewhat less effective (and again nearly identical) is a second pair of substances, corn-silk extract and S-Methyl-iso-thiourea sulphate. The dosage of the latter (0.5 mgm/kgm in a 1.10^5 solution) is 5 times higher than the dosage of the former (0.1 mgm/kgm in a 1.10^6 solution). Finally ephedrine sulphate (0.01 mgm/kgm in a 1.10^6 solution) trails as the least effective one at the end of the line.

The present report deals with corn-silk extract and the aforementioned comparison gives it a place in the middle of the group. The two thiourea compounds, flanking it, were both needed in a 5 times higher dosage. One can, perhaps, say therefore, that corn-silk-extract has certain possibilities in the alleviation of human hypertension. Corn-silk extract is now used little in practical medicine, one of the partly forgotten medicines. Which does not mean, however, that it might not possess effects hitherto unsuspected, such as the ones reported here.

In the battle against this human scourge of global and timeless dimensions-hypertension in all its forms and varieties-substances produced by plants might be of use eventually. Recently the U.S. Department of Agriculture has developed and studied rutin, derived from buck-wheat, which shows promising features as a weapon in this battle. Another one is salsolin (11), a 1-methyl-6-hydroxy-7-methoxy-tetra-hydro-iso-quinoline isolated a few years ago from a desert plant (Salsola Richteri), growing in Southern Siberia, by scientists of the U.S.S.R. Definitely beneficial effects in hypertension are claimed for it by the Russian medical profession. And many times and at many places, the garlic-group has been tried as a weapon, also with certain claims as to some efficiency.

SUMMARY

Corn-silk extract (*Stigmata maydis zcae*) was tested in 1.10^5 aqueous solutions (1 cc per 100 gms rat intraperitoneally or a dosage of 0.1 mgm/kgm) with 12 normotensive and 28 hypertensive rats. The systolic blood pressure was measured for a number of days prior to

injections, 24 hours after each injection (administered for 4 consecutive days) and for 4 more days following cessation of injections. No (significant) influence on the blood pressures of normotensives was observed. Hypertensive animals, however, responded with a moderate reduction of blood pressure. Its average declined by -15.0 , -13.2 and -12.8 mmHg with low, medium and high hypertension groups respectively, when all 4 days of the treatment are pooled. This means a reduction of the hypertension *per se* (-18 , -35 and -70 mmHg, average values) of these three subgroups to 16.7 %, 62.3 % and 81.7 % of the pre-treatment values of it. A return to the pre-injection pressure level was complete on the second day after cessation of the injection. No trace of any adverse effect whatsoever was observed.

REFERENCES

1. — BOERICKE, WM. Homeopathic Materia Medica. 611, 1927.
2. — KRAEMER, H. Scientific and Applied Pharmacognosy. 80, 1915.
3. — SOLIS-COHEN, S. AND STOTESBURY GITHENS, TH. Pharmacotherapeutics, Materia Medica and Drug Action. 846, 1928.
4. — Experimental Hypertension. *Special Publications of the New York Academy of Sciences*. Vol. III, 179, 1946.
5. — GROLLMAN, A. AND HARRISON, T. R. Reduction of blood pressure of hypertensive rats by administration of certain marine oils. *Proc. Soc. Exp. Biol. Med.* 52, 162, 1943.
6. — WILLIAMS, J. R., HARRISON, T. R. AND GROLLMAN, A. A simple method for determining the systolic blood pressure of the un-anesthetized rats. *J. Clin. Invest.* 18, 373, 1939.
7. — WASTL, H. The effects of pareдрine hydrobromide on experimental hypertension. *Hahnemannian Monthly*, 77, 611, 1942.
8. — WASTL, H. Influence of pareдрine hydrobromide on experimental hypertension in the rat. *Hahnemannian Monthly*, 79, 273, 309, 1944.
9. — WASTL, H. Influence of two thiourea derivatives on blood pressure in hypertensive rats. *Arch. Internat. Pharmacodynamie Therapie*, 71, 204, 1945.
10. — WASTL, H. Influence of ephedrine sulphate on blood pressure in hypertensive rats. *Hahnemannian Monthly*, 81, 71, 1946.
11. — WASTL, H. Salsolin, a new drug in the treatment of hypertension. *Hahnemannian Monthly*, 81, 243, 1946.

38

Wodicka, V. O.

1971

Regulation of Food Additives and Medicated
Animal Feeds

In "Hearings Before a Subcommittee of the
Committee on Government Operations, House of
Representative, Ninety-second Congress
First Session, March 16-18;
29-30, 1971

U. S. Government Printing Office
Washington, D.C.

Page 257

BIOLOGICAL DATA

Corn Silk (Zea)

I. Acute Toxicity

A. Frogs

Dzhamaliev (11) injected frogs, (average weight 50 grams), two to five per group, with corn silk infusion (20% aqueous), 5 ml to 9 ml per animal (20,000 to 36,000 mg/kg BW), via the abdominal lymph sac. A series of control animals, one to three per group, were injected with like volumes of 0.65% sodium chloride solution. The animals were observed for toxic signs and mortalities. Results are presented below in Tables 5 and 6.

Apathy, incoordination, and intermittent breathing preceded death. At autopsy, the heart was observed to have stopped in diastole with greatly dilated atria, the liver was reduced in size and gray-green in color, and a large amount of slightly yellowish lymph fluid was found in the abdominal cavity.

Frogs given sublethal doses of corn silk infusion also became apathetic and edematous but returned to normal in 1-1/2 to 2 weeks.

B. Dogs

The same author (11) gave two dogs weighing 7.15 kg and 8.15 kg, (strain, age, and sex not specified), by stomach probe, 20% corn silk infusions (aqueous), at levels of 5000 and 6574 mg/kg BW, and observed the animals over a 10-day period.

Both animals survived and gained weight. Neither showed any toxic effects.

II. Short-Term Studies

A. Guinea pigs

Dzhamaliev (11) studied in a 12-day experiment the effect on guinea pigs, 360-435 grams BW, (strain, sex, and age not mentioned), of repeated doses of 20% corn silk infusion (aqueous) injected subcutaneously (See Table 7 for dosage schedule). The animals were observed for local effects, weight change, and toxic signs.

Table 5. Acute Toxicity of Corn Silk and Carvacrol
(Essential Oil Constituent)

Substance	Animal	Sex & No.	Route	Dosage mg/kg	Measurement	Reference Bibliography No.
Corn Silk	Frogs	18	Abdominal lymph sac	24,000	MLD	Dzhamalieva (11)
Corn Silk	Dogs	2	p.o.	> 6574	MLD	Dzhamalieva (11)
Carvacrol	Frogs	--	s.c.	75	LD	Spector (32)
Carvacrol	Rats	M&F 10/group	p.o.	810	LD ₅₀	Christiansen (08)
Carvacrol	Rabbits	--	p.o.	100	LD	Stecher (34)
Carvacrol	Rabbits	--	s.c.	1000	LD	Spector (32)
Carvacrol	Cats	--	p.o.	100	LD	Spector (32)

A marked weight loss (30-40 grams) one day after the second injection was the only significant symptom noted. Starting one day later, however, there was a gradual weight gain, with the original weight being attained or exceeded by the 12th day of the experimental period. The single control animal did not experience a weight loss.

B. Rabbits

The same author (11) investigated the action of corn silk infusions on rabbits over a period of eight days in animals given multiple injections intravenously, or both intravenously and subcutaneously. (See Table 8 for dosage schedule).

Loss of weight was the only adverse effect noted. Four days following the first injection, the weight of all animals decreased by 50 to 135 grams. Three days after the second injection, the weight loss ranged from 65 to 275 grams.

C. Dogs

Dzhamalieva (11) also determined the effect on dogs of corn silk infusion (aqueous) administered subcutaneously in divided doses in a ten-day experiment.

One animal (10.05 kg BW) was injected with 418 mg/kg initially and five days later received 200 mg/kg. A second dog (15.6 kg BW) was given 200 mg/kg the first day and 130 mg/kg, five days later. The animals were observed for toxic signs and weight change over the experimental period of ten days.

The second animal lost 300 grams during the study; the other gained 700 grams. There were no signs of systemic toxic effects in either animal.

Corn Silk Fluidextract

Rats

Wastl (37) reported that no trace of any adverse effect whatsoever was detected in forty normotensive and hypertensive rats treated with corn silk extract injected intraperitoneally, at a level of 0.1 mg/kg BW, daily for four consecutive days (See BIOCHEMICAL ASPECTS, IV, Corn Silk Fluidextract),

III. Long-Term Studies

No information

IV. Special Studies

A. Effect on pathogenic bacteria in vitro

Dzhamalieva (11) reported that a corn silk infusion (aqueous) in concentrations of 3, 5, 10, and 20% was neither bactericidal nor bacteriostatic in vitro for the following bacteria: Staphylococcus albus, Streptococcus species, Bacterium coli commune, Bacterium dysenteriae Flexner, Bacterium dysenteriae Shiga, Bacterium typhi abdominalis, Brucella abortus bovis, Brucella suis, Bacillus anthracis.

B. Hemolytic action in vitro

Berger (06) stated that a 1:10,000 decoction of corn silk caused complete hemolysis, within a few minutes, of a suspension of blood corpuscles in physiologic saline solution in vitro (06). One of the constituents of corn silk with known hemolytic properties are the saponins which are present in amounts of 2-4% (06,19).

C. Effect on kidney stones in vitro

Dzhamalieva (11) studied the effect of corn silk infusion on kidney stones in vitro in an investigation prompted by the empirical use of the substance in the treatment of urolithiasis in man.

Various types of kidney stones (carbonate, oxalate, phosphate, urate) removed surgically from patients were subjected to 3, 5, 10, and 20% aqueous corn silk infusion over a period of 50 days under controlled conditions in vitro. The solutions were replaced every three or four days. In some instances, mixtures of human urine and corn silk were used; results were the same.

Kidney stones consisting of carbonates were gradually dissolved by the action of corn silk. Those containing phosphate and urate were disintegrated with the formation of "sand". The corn silk infusion did not have any noticeable effect on kidney stones consisting of oxalates.

Table 6. Effect of Corn Silk Infusion (20%) on Frogs (Via the abdominal lymph sac) (11).

Material	Volume injected	No. Frogs	Results Deaths/Total
Corn Silk	9	2	2/2
	8	4	4/4
	7	5	2/5
	6	4	3/4
	5	3	0/3
0.65% NaCl	9	1	0/1
	8	3	0/3
	7	2	0/2
	6	1	0/1
	5	1	0/1

Table 7. Effect of Corn Silk Infusion (20%) on Guinea Pigs^a (11)

Dosage Schedule					
Animal No.	First Day ml	mg/kg	Fifth Day ml	mg/kg	Total Dosage mg/kg
4	7	3522	12.5	6289	9811
1	8	4025	11.5	5780	9805
2	9	4528	12.5	6289	10,817
5	10	5031	12.5	6289	11,320
3	0	0	0	0	0

^a Mean body weight: 397.5 grams

Table 8. Effect of Corn Silk Infusion (20%) on Rabbits (11)

Dosage Schedule

Animal No.	Body weight (kg)	<u>First Day</u>		<u>Fifth Day</u>		<u>mg/kg</u>		Total Dosage mg/kg
		<u>ml</u>	<u>mg/kg</u>	<u>ml</u>	<u>s.c.</u>	<u>i.v.</u>	<u>s.c.</u>	
1	1.70	9	1059	9.5	0	1120	0	2179
2	1.64	14	1707	7.0	0	854	0	2561
3	1.97	10	1015	3.0	10	305	1015	2335
4	1.75	10	1143	5.0	4	572	457	2172
5	1.61	10	1242	9.0	0	1118	0	2360

BIOCHEMICAL ASPECTS

Corn Silk (Zea)

I. Breakdown

No information

II. Absorption-Distribution

No information

III. Metabolism and Excretion

No information

IV. Effects on Enzymes and Other Biochemical Parameters

McMillian et al. (25) and Starks et al. (33) discovered a water-soluble feeding stimulant for corn earworm larvae in corn silk. Extracts of young silks, three days after emergence, were preferred by the larvae (25). No toxic effects of any kind were reported by the authors. In the field, the female earworm prefers to oviposit in fresh, 3-day silks, and the newly hatched earworms feed on the silk mass for 8-10 days before reaching the kernels (25). Young silks are the type preferred also for corn silk therapeutic preparations used in human medicine (06,27).

Dzhamalieva (11) reported that intravenous injection of dogs with a 5% corn silk infusion (aqueous) raised the blood pressure. He warned that infusions stronger than 3% cannot be recommended in treating urolithiasis in older people or in patients with hypertonic disease.

Berger (06) reported that an alkaloid (unidentified) in corn silk, when inhaled, caused psychic excitation, delirium, and tremors after prolonged use (06). The side-effects of its use were increased salivary flow, vomiting, colics, and watery diarrhea (06).

Various investigators have briefly mentioned corn silk as having physiologic effects as a: diuretic (06,11,19,27,35), heart

stimulant (06,27), hypertensive (11), purgative (06), bile secretion stimulant (11), blood coagulant (11), anti-diabetic (11), anti-obesic (06,19), narcotic (19), psychic excitant (06).

Dzhamalieva (11) reported that in addition to increasing bile secretion, corn silk reduced its solid residue and lowered viscosity density, and bilirubin content (11).

Corn Silk Fluidextract

Wastl (37) reported in 1947 that corn-silk extract was moderately effective in lowering blood pressure of experimentally-hypertensive rats.

Adult animals, (White Wistar and a piebald strain), both sexes, all about the same age (280 grams, average weight), in an eight day study, were treated with an aqueous solution of corn-silk extract, daily doses of 0.1 mg/kg BW, for four consecutive days via the intraperitoneal route. (The treated animals had been made permanently hypertensive previously by looping a stout cotton thread in a figure 8 over the poles of both kidneys (See original article for details)). Twelve rats with low hypertension, 10 with medium hypertension and 6 with high hypertension were used. Twelve normotensive (control) animals were included also. The hypertensive and control groups contained equal numbers of both sexes. The systolic blood pressure was determined for a number of days before the treatment, 24 hours after each injection, and daily for four days after the last dose. The data are presented in Table 9, and Figure 2. Comparative effects of several other therapeutic agents are shown in Table 10 and Figure 3 (37).

The hypertensive animals responded to treatment with corn-silk extract with a moderate reduction of blood pressure (37). There was a reduction of hypertension per se in the low, medium, and high hypertension groups to 16.7%, 62.3%, and 81.7% of the pretreatment values (37). The return to preinjection pressure levels was complete the second day after cessation of treatment (37).

No significant effect on the blood pressure of the normotensive (controls) rats was observed (37). No toxic effects were detected in any of the treated animals.

The author indicated that in earlier studies, corn silk extract caused the same effect via the oral route.

Table 9. Average Systolic Blood Pressure (mmHg) Corn-Silk Extract Dosage:
0.1 mgm/kgm (37)

Degree of hypertension	Nr. of animals	Normal blood pressure		Hypertension		Injections				Range of values	Cessation of Injections				Hypertension perse	
		Average	Range of values	Average	Range of values	Days					Days				Average	Range of values
						1	2	3	4		1	2	3	4		
<i>Hypertensives</i>																
Low + 14.3 % average	12	126	110 to 138	144	110 to 158	128	124	131	133	84 to 156	142	144	144	144	18	0 to 26
Medium + 28.2 % average	10	124	116 to 136	159	146 to 172	146	142	147	148	122 to 166	156	159	159	159	35	26 to 46
High -- 55.1 % average	6	127	120 to 134	197	186 to 210	184	180	186	187	170 to 210	195	197	197	197	70	00 to 88
<i>Normotensives</i>																
—	12	128	108 to 140	—	—	127	126	127	128	98 to 139	128	128	128	128	—	—

Total: 40 (20 male and 20 female animals).

Average weight of all groups: 280 gms.

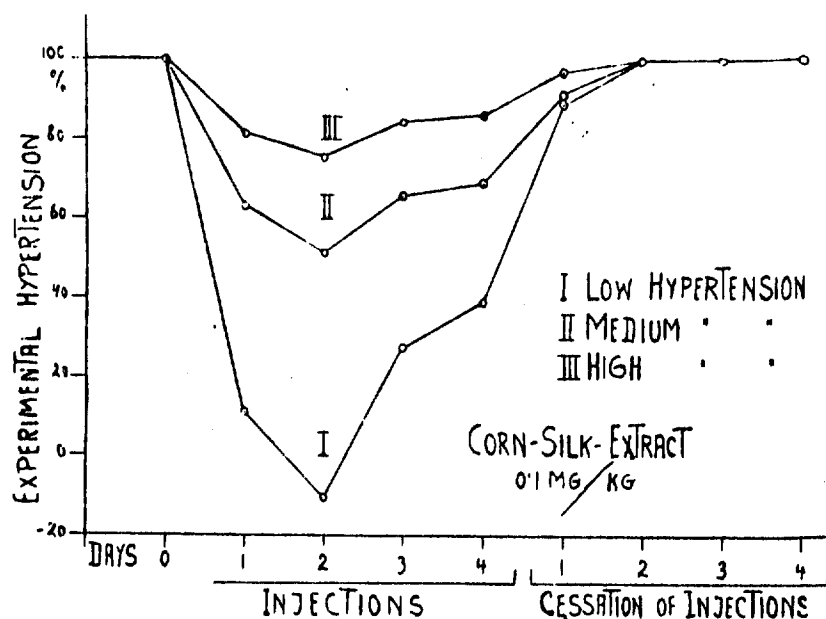
Range of individual weights: 190-425 gms

Low hypertension from 0 to + 20%

Medium hypertension from + 20% to + 40%

High hypertension over + 40%

Permanently over the individual normal systolic blood pressure prior to kidney operation



(*) The values of actual decreases (mmHg) observed range between :

1	2	3	4	Days of injections.
to - 24	- 10 to - 34	0 to - 22	0 to - 30	Low hypertension.
- 26	- 6 to - 38	0 to - 28	0 to - 18	Medium hypertens.
- 16	- 14 to - 22	0 to - 20	0 to - 20	High hypertension.

(*) Blood pressure measurements immediately after or within a few hours after the shock of an intraperitoneal injection are frequently falsified in a certain extent. The wide margin of a 24 hour interval has been chosen to avoid such a filtration and to get a picture of longer range effects.

Fig. 2 Effect of Corn-Silk Extract Injections on Experimental Hypertension (37)

Table 10. Average Decrease of Systolic Blood Pressure in mmHg. Hypertensive Animals. All Subgroups Combined. (37)

Drug	Nr of animals	Hypertension		Injections				Cessation of Injec.			
		Average	Range of values	Days							
				1	2	3	4	1	2	3	4
Paredrine-HBr 0.008 mgm/kgm	50	168	120 to 228	22.3	24.0	25.7	26.8	5.1	1.1	0	0
S-Benzyl-iso-thiourea-HCl 0.5 mgm/kgm	26	169	124 to 220	23.3	23.3	21.7	17.0	5.7	2.7	0	0
Corn-silk extract 0.1 mgm/kgm	28	167	110 to 210	14.0	18.0	12.0	10.7	2.3	0	0	0
S-Methyl-iso-thiourea-sulfate 0.5 mgm/kgm	24	169	122 to 218	15.3	15.3	14.0	12.0	3.7	1.3	0	0
Ephedrine-sulphate 0.01 mgm/kgm	50	168	122 to 220	7.3	8.7	8.3	5.7	2.0	0.7	0	0

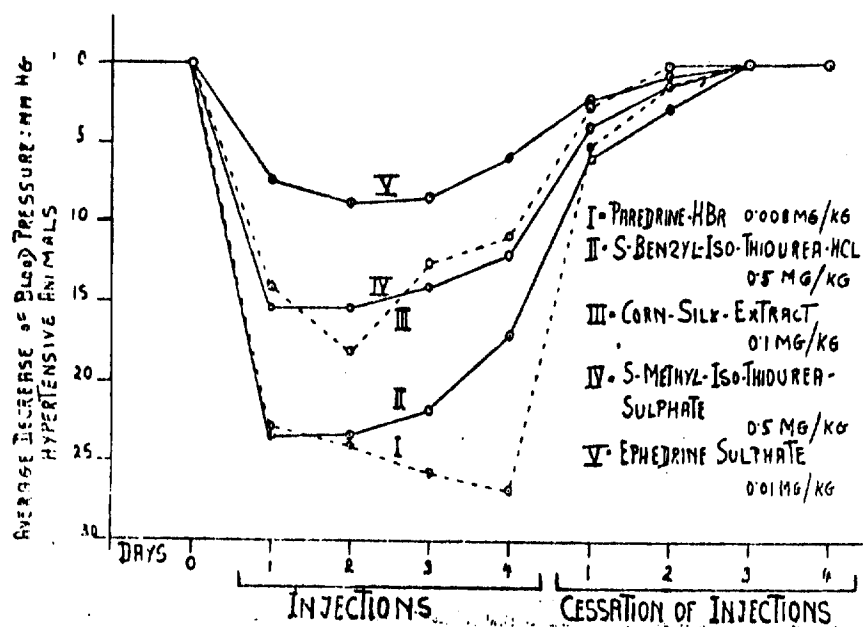


Fig. 3 Average Decrease of Blood Pressure in Hypertensive Animals (37)

Corn Silk (Zea) and Corn Silk Fluidextract

Corn Silk (Zea) and Corn Silk Fluidextract have been used over the years for the treatment of a variety of human diseases: heart disease accompanied by edema (06,19,27), disorders of the kidneys and urinary tract (pyelitis (06), urolithiasis (11), cystitis (06,27) bladder spasms (06), subacute catarrh of bladder and renal pelvis (11), urethritis (06,27), micturition problems (06), obesity (06,19), diabetes (19), gout (06), rheumatism (06), and gonorrhea (06,35). The dosage of Corn Silk (Zea) is 4-12 grams (27).

According to one authority corn silk is probably of little value in the treatment of dropsy of heart disease (27).

V. Drug Interaction

No information

Corn Silk (Zea)

VI. Consumer Exposure

Corn silk is a direct food additive employed as a flavoring ingredient in maple, nut, and root beer flavors (12). Foods in which it is used are non-alcoholic beverages, ice cream and ices, candy, and baked goods (12,15). Its use in the food industry is regulated along with other essential oils, oleoresins, and natural extractives that are generally regarded as safe for their intended use within the meaning of Federal food additive regulations (03).

Estimated average daily intakes of corn silk from all food categories, according to the Comprehensive GRAS Survey - NAS/NRC 1972, range from 0.1 mg for infants (0-5 months of age) to 3.83 mg for children and adults (2-65+ yrs of age) (See Table 11) (13). Maximum estimated daily intakes vary from 0.17 mg for infants to 7.31 mg for children and adults (See Table 11) (13).

Foods in which corn silk (Zea) is employed at the maximum use level, as reported in the Comprehensive GRAS Survey, are baked goods (26.4 ppm), beverages type I (21.5 ppm), and soft candy (16.7 ppm) (See Table 12) (13).

The total 1970 poundage reported to FEMA and NAS (5 reports) was 405 pounds (13).

Table 11. Possible Daily Intakes of FEMA Questionnaire Substances Not in NAS Appendix A (Group III), Per Food Category and Total Dietary, Based on Food Consumption by Total Sample. (13)

Substance Name (Survey No.)	Food Category No.	Food Category Name	No. of Firms	Possible Daily Intake,			
				Age	Average	High A	High B
Corn Silk FEMA 2335A	01	Baked Goods(R)	4	0-5 mo.	0.060941	0.080657	0.089837
				6-11 mo.	0.455262	0.928449	0.671137
				12-23 mo.	0.976843	1.609550	1.440039
				2-65+ yr.	2.459134	3.652854	3.625199
	07	Frozen Dairy(R)	-	0-5 mo.	0.004905	0.020111	0.010884
				6-11 mo.	0.046599	0.129497	0.103395
				12-23 mo.	0.070635	0.165795	0.156725
				2-65+ yr.	0.125573	0.302650	0.278623
	16	Soft Candy (R)	4	0-5 mo.	0.002112	0.021122	0.003333
				6-11 mo.	0.023234	0.071816	0.036664
				12-23 mo.	0.036964	0.098218	0.058328
				2-65+ yr.	0.061254	0.185875	0.096658
	20	Gelatin Pud (R)	-	0-5 mo.	0.002665	0.003597	0.005419
				6-11 mo.	0.017054	0.051695	0.034683
				12-23 mo.	0.018386	0.044766	0.037392
				2-65+ yr.	0.027180	0.069948	0.055275
	23	Bev. Type I(R)	4	0-5 mo.	0.026634	.039950	0.051714
				6-11 mo.	0.251909	0.862261	0.489128
				12-13 mo.	0.601474	1.803313	1.167874
				2-65+ yr.	1.154120	3.081724	2.240939
	24	Bev. Type II(R)	-	0-5 mo.	0.000000	0.000000	0.000000
				6-11 mo.	-----	0.000015	-----
				12-23 mo.	-----	0.000030	-----
				2-65+ yr.	0.004875	0.014160	0.006500
	99	All Categories	5	0-5 mo.	0.097256	0.165438	0.161187
				6-11 mo.	0.794059	2.043732	1.335007
				12-23 mo.	1.704302	3.721673	2.860359
				2-65+ yr.	3.832137	7.307211	6.303194

Table 12. Usage Levels Reported for FEMA Questionnaire Substances Not in NAS
Appendix A (Group III) - Regular Foods Only. (13)

Substance Name (Survey No.)	No.	Food Category Name	No. Firms Reporting	Usual Use WTD Mean, P.P.M	Maximum Use WTD Mean, PPM
Corn Silk FEMA 2335A	01	Baked Goods (R)	4	17.923720	26.422736
	07	Frozen Dairy (R)	-	4.905183	10.883692
	16	Soft Candy (R)	4	10.561105	16.665250
	20	Gelatin Pud (R)	-	1.332335	2.709581
	23	Bev. Type I (R)	4	11.097312	21.547486
	24	Bev Type II (R)	-	0.150000	0.200000
	49	Misc. Unclass. (R)	-	1.700000	3.900000

BIBLIOGRAPHY

- 1 Aliev, R.K. 1947
Data on the characteristics of the chemical composition and blood coagulating action of corn stigma (Russian)
Baku
- 2 Altland, P.D., H.F. Brubach, M.G. Parker, M.P. Dieter, and M. Murayama. 1971
Effects of smoke on tolerance of rats to hypoxia
J. Appl. Physiol. 30(3):353-357
- * 3 Anon. 1972
Food and Drugs: Substances that are generally recognized as safe
Code of Federal Regulations, 21CFR 121.101 29
- 4 Barber, G.W. 1944
Mineral oils, alone or combined with insecticides, for control of earworms in sweet corn
USDA Tech. Bull. 880:1-83
- 5 Beare, J.L., T.L. Murray and J.A. Campbell 1960
Responses of two strains of rats to rapeseed oil and corn oil
J. Biochem. 38:187-192
- * 6 Berger, Franz 1949
Pharmacology Handbook: Identification, Evaluation, and Use. Vol. 1, Methods of Investigation, Cortices-Flores
Wilhelm Maudrich, Vienna 318-319
- 7 Boericke, W. 1927
Homeopathic Materia Medica
611
- * 8 Christensen, H.E., Editor 1973
Toxic Substances List, 1973 Edition
U.S. Dept. of Health, Education and Welfare, Natl. Inst. for Occupational Safety & Health, Rockville, Md. 230
- * 9 Committee on Specifications 1972
Food Chemicals Codex, 2nd edition
Committee on Food Protection, National Academy of Sciences, National Research Council, Washington, D.C. 175-176
- 10 Dethier, V.G., L.B. Browner, and C.N. Smith 1960
The designation of chemicals in terms of responses they elicit from insects
J. Econ. Entomol. 53:134-136
- * 11 Dzhamalleva, I.B.D. 1954
Pharmacological action of a corn silk (stygmeta mags) infusion.
Izvest. Akad. Nauk. Kazakh. S.S.R., No. 127, Ser. Fiziol. Med. No. 3, 81-93
- * 12 Food Protection Committee, Food and Nutrition Board 1965
Chemicals Used in Food Processing
National Academy of Science, National Research Council, Washington, D.C. Publication 1274 96:225
- * 13 Food Protection Committee 1972
Comprehensive GRAS Survey
National Academy of Sciences, National Research Council, Washington, D.C. 6; 21:114-115
- 14 Freise, W. 1936
Über Stigmata Maidis (Maisgriffel)
Pharm. Zentralb. 77 Jahrgang 616-617
- * 15 Furia, T.E. and N. Bellanca 1971
Fenareli's Handbook of Flavor Ingredients
The Chemical Rubber Company, Cleveland Ohio 95
- 16 Gleason, M.N., R.E. Gosselin, H.C. Hodge, and R.P. Smith 1969
Clinical Toxicology of Commercial Products
The Williams & Wilkins Company, Baltimore, Maryland 31:189-192
- 17 Gnadt, A.F. 1946
Über insulin und andere antidiabetisch wirkende stoffe und zubereit ungen
Pharmazie 1:103-107

- 18 Hall, R.L. and B.L. Oser 1965
Recent progress in the consideration of
flavoring ingredients under the Food
Additives Amendment: III. GRAS
substances
Food Technol. 19(2):253-299
- * 19 Hoppe, Heinz A. 1958
Pharmacology--Manual of Vegetable and
Animal Raw Materials (German)
Cram, De Gruyter & Company, Hamburg,
Germany, 962
- 20 Howard, W.A., R.H. Todd and G.L.
Dalton 1959
Studies on the allergenicity of corn
products
J. Allergy. 30:381-386
- 21 Jenner, P.M., E.C. Hagan, J.M. Taylor,
E.L. Cook, and O.G. Fitzhugh 1964
Food Flavorings and Compounds of Related
Structure, I. Acute Toxicity
Food Cosmetics Toxicol. (London) 2:327-343
- 22 Kochmann, M. 1931
Chlorocarvacrol als anthelmenticum
(Carvasept) (German)
Arch. Exp. Pathol. Pharmacol. 161:196-205
- 23 Kraemer, H. 1915
Scientific and Applied Pharmacognosy
80
- 24 Labarga, C., P.B. Nicholis and R.S.
Bandurski 1965
A partial characterization of indoleacetyl-
inositols from Zea mays
Biochem. Biophys. Res. Comm., 20(5):641-646
- * 25 McMillian, W.W., B.R. Wiseman, and
A.A. Sekul 1970
Further studies on the responses of corn
earworm larvae to extracts of corn silks
and kernels
Ann. Entomol. Soc. Am. 63(2):371-378
- 26 Mohnike, G. 1947
Klinische untersuchungen mit linum aus
Stigmata Maidis, Maisnarben, gewonnenen
antidiabeticum
Pharmazie 2:21-24
- * 27 Osol, A., and G.E. Farrar, Jr. 1967
The Dispensatory of the United States
of America, 25th edition
J.B. Lippincott Company, Philadelphia,
Pennsylvania Part II, p. 1932
- 28 Phillips, W.J. and G.W. Barber 1933
Egg-laying habits and fate of eggs of
the corn earworm moth and factors
affecting them
Va. Agr. Exp. Sta. Bull. 47:1-14
- * 29 Rademaker, C.J. and J.L. Fischer 1886
Proximate analysis of Stigmata maydis
Am. J. Pharm. 58:369-370
- 30 Reichert 1952
Arzneim. Forsch. 2:20
- 31 Selis-Cohen, S. and Th. Stotesbury
Githens 1928
Pharmaco-Therapeutics, Materia Medica,
and Drug Action
846
- * 32 Spector, W.S. 1956
Handbook of Toxicology, Vol. I: Acute
Toxicities
W.B. Saunders Company, Philadelphia,
Pennsylvania 60-61:298-301
- * 33 Starks, K.J., W.W. McMillian, A.A.
Sekul, and H.C. Cox 1965
Corn earworm larval feeding response to
corn silk and kernel extracts
Ann. Entomol. Soc. Am. 58:74-76
- * 34 Stecher, P.G. (ed.) 1968
The Merck Index An Encyclopedia of
Chemicals and Drugs, 8th edition
97; 105; 621; 494; 214
- * 35 Tsukinaga K. 1931
On the nitrogen free components of corn
silk.
Res. Bull. Agr. Exp. Sta. So. Manchuria
Railway Co. 2:59-68

- 36 Von Oettingen, W.F. 1949
Phenol and its derivatives. The relation
between their chemical constitution and
their effect on the organism
Natl. Inst. Health Bull. No. 190
- * 37 Wastl. H. 1947
Observations of influence of corn-silk
extract (*Stigmata maydis zeae*) on
blood pressure in hypertensive rats
Arch. Inst. Pharmacodyn. 74:1-8
- * 38 Wodicka, V.O. 1971
Regulation of Food Additives and Medicated
Animal Feeds
In Hearings before a subcommittee of the
Committee on Government Operations, House
of Representatives, Ninety-second Congress,
First Session, March 16-18; 29-30, 1971, U.S.
Govt. Print. Off. Washington, D.C. p. 527

COPIES OF ARTICLES

CITED IN TEXT

Chapter I—Food and Drug Administration

§ 121.101

Subpart B—Exemption of Certain Food Additives From the Requirement of Tolerances

§ 121.101 Substances that are generally recognized as safe.

(a) It is impracticable to list all substances that are generally recognized as safe for their intended use. However, by way of illustration, the Commissioner regards such common food ingredients as salt, pepper, sugar, vinegar, baking powder, and monosodium glutamate as safe for their intended use. The lists in paragraph (d) of this section include additional substances that, when used for the purposes indicated, in accordance with good manufacturing practice, are regarded by the Commissioner as generally recognized as safe for such uses.

(b) For the purposes of this section, good manufacturing practice shall be defined to include the following restrictions:

(1) The quantity of a substance added to food does not exceed the amount reasonably required to accomplish its intended physical, nutritional, or other technical effect in food; and

(2) The quantity of a substance that becomes a component of food as a result of its use in the manufacturing, processing, or packaging of food, and which is not intended to accomplish any physical or other technical effect in the food itself, shall be reduced to the extent reasonably possible.

(3) The substance is of appropriate food grade and is prepared and handled as a food ingredient. Upon request the Commissioner will offer an opinion, based on specifications and intended use, as to whether or not a particular grade or lot of the substance is of suitable purity for use in food and would generally be regarded as safe for the purpose intended, by experts qualified to evaluate its safety.

(c) The inclusion of substances in the list of nutrients does not constitute a finding on the part of the Department that the substance is useful as a supplement to the diet for humans.

(f) *Trace minerals added to animal feeds.*¹ These substances added to animal feeds as nutritional dietary supplements are generally recognized as safe when added at levels consistent with good feeding practice.

Element	Source compounds
Cobalt-----	Cobalt acetate. Cobalt carbonate. Cobalt chloride. Cobalt oxide. Cobalt sulfate.
Copper-----	Copper carbonate. Copper chloride. Copper gluconate. Copper hydroxide. Copper orthophosphate. Copper oxide. Copper pyrophosphate. Copper sulfate.
Iodine-----	Calcium iodate. Calcium iodobenzenate. Cuprous iodide. 2,5-Dihydroxybenzoic acid. Ethylenediamine dihydrochloride. Potassium iodate. Potassium iodide. Sodium iodate. Sodium iodide. Thymol iodide.
Iron-----	Iron ammonium citrate. Iron carbonate. Iron chloride. Iron gluconate. Iron oxide. Iron phosphate. Iron pyrophosphate. Iron sulfate. Reduced iron.
Manganese-----	Manganese acetate. Manganese carbonate. Manganese citrate (soluble). Manganese chloride. Manganese gluconate. Manganese orthophosphate. Manganese phosphate (di-basic). Manganese sulfate. Manganous oxide.
Zinc-----	Zinc acetate. Zinc carbonate. Zinc chloride. Zinc oxide. Zinc sulfate.

(g) Synthetic flavoring substances and adjuvants that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

¹ All substances listed may be in anhydrous or hydrated form.

Acetaldehyde (ethanal).
Acetoin (acetyl methylcarbinol).
Aconitic acid (equiabetic acid, citridic acid, achillic acid).
Anethole (parapropenyl anisole).
Benzaldehyde (benzoic aldehyde).
N-Butyric acid (butanoic acid).
d- or l-Carvone (carvol).
Cinnamaldehyde (cinnamic aldehyde).
Citral (2,6-dimethyloctadien-2,6-di-8, geranial, neral).
Decanal (N-decylaldehyde, capraldehyde, capric aldehyde, caprinaldehyde, aldehyde C-10).
Diacetyl (2,3-butanedione).
Ethyl acetate.
Ethyl butyrate.
3-Methyl-3-phenyl glycidic acid ethyl ester (ethyl-methyl-phenyl-glycidate, so-called strawberry aldehyde, C-16 aldehyde).
Ethyl vanillin.
Eugenol.
Geraniol (3,7-dimethyl-2,6 and 3,6-octadien-1-ol).
Geranyl acetate (geraniol acetate).
Glycerol (glyceryl) tributyrinate (tributyrin, butyrin).
Limonene (d-, l-, and dl-).
Linalool (linalol, 3,7-dimethyl-1,6-octadien-3-ol).
Linalyl acetate (bergamol).
1-Malic acid.
Methyl anthranilate (methyl-2-aminobenzoate).
Piperonal (3,4-methylenedioxy-benzaldehyde, heliotropin).
Vanillin.

(h) Substances migrating to food from paper and paperboard products used in food packaging that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

Acetic acid.
Alum (double sulfate of aluminum and ammonium potassium, or sodium).
Aluminum hydroxide.
Aluminum oleate.
Aluminum palmitate.
Ammonium chloride.
Ammonium hydroxide.
Calcium chloride.
Calcium hydroxide (lime).
Calcium sulfate.
Casein.
Cellulose acetate.
Clay (kaolin).
Copper sulfate.
Cornstarch.
Corn sugar (syrup).
Dextrin.
Diatomaceous earth filler.
Ethyl cellulose.
Ethyl vanillin.
Ferrous sulfate.
Ferroic acid or sodium salt.
Formic acid or sodium salt.

Glycerin.
Guar gum.
Invert sugar.
Iron, reduced.
Locust bean gum (carob bean gum).
Magnesium carbonate.
Magnesium chloride.
Magnesium hydroxide.
Magnesium sulfate.
Methyl and ethyl acrylate.
Mono- and diglycerides from glycerolysis of edible fats and oils.
Oleic acid.
Oxides of iron.
Potassium sorbate.
Propionic acid.
Propylene glycol.
Silicon dioxides.
Pulps from wood, straw, bagasse, or other natural sources.
Soap (sodium oleate, sodium palmitate).
Sodium aluminate.
Sodium carbonate.
Sodium chloride.
Sodium hexametaphosphate.
Sodium hydrosulfite.
Sodium hydroxide.
Sodium phosphoaluminate.
Sodium silicate.
Sodium sorbate.
Sodium sulfate.
Sodium thiosulfate (additive in salt).
Sodium tripolyphosphate.
Sorbitol.
Soy protein, isolated.
Sulfamic acid.
Sulfuric acid.
Starch, acid modified.
Starch, pregelatinized.
Starch, unmodified.
Sucrose.
Talc.
Urea.
Vanillin.
Zinc hydrosulfite.
Zinc sulfate.

(i) Substances migrating to food from cotton and cotton fabrics used in dry food packaging that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

Acacia (gum arabic).
Acetic acid.
Beef tallow.
Calcium chloride.
Carboxymethylcellulose.
Coconut oil, refined.
Corn dextrin.
Cornstarch.
Fish oil (hydrogenated).
Gelatin.
Guar gum.
Hydrogen peroxide.
Japan wax.
Lard.

Lard oil.
Lecithin (vegetable).
Locust bean gum (carob bean gum).
Oleic acid.
Peanut oil.
Potato starch.
Sodium acetate.
Sodium bicarbonate.
Sodium carbonate.
Sodium chloride.
Sodium hydroxide.
Sodium sulfate.
Sodium silicate.
Sodium tripolyphosphate.
Sorbitol.
Soybean oil (hydrogenated).
Stearic acid.
Talc.
Tall oil.
Tallow (hydrogenated).
Tallow flakes.
Tapioca starch.
Tartaric acid.
Tetrasodium pyrophosphate.
Urea.
Wheat starch.
Zinc chloride.

(Secs. 201(a), 409, 701(a), 52 Stat. 1055, 72 Stat. 1784, 1785 et seq., as amended; 21 U.S.C. 321(a), 348, 371(a)) [30 F.R. 15845, Dec. 23, 1965, as amended at 33 F.R. 5619, Apr. 11, 1968; 34 F.R. 17084, Oct. 21, 1969; 35 F.R. 1049, Jan. 27, 1970]

§ 121.102 Adjuvants for pesticide chemicals.

Adjuvants, identified and used in accordance with 40 CFR 180.1001 (c) and (d), which are added to pesticide use dilutions by a grower or applicator prior to application to the raw agricultural commodity, are exempt from the requirement of tolerances under section 409 of the act.

(Sec. 409, 72 Stat. 1785; 21 U.S.C. 348)

Subpart C—Food Additives Permitted in Feed and Drinking Water of Animals or for the Treatment of Food-Producing Animals

AUTHORITY: The provisions of this Subpart C issued under sec. 409, 72 Stat. 1785; 21 U.S.C. 348, unless otherwise noted.

§ 121.200 Definitions and interpretations applicable to Subpart C.

(a) Regulations prescribing conditions under which additives may be safely used in animal feed, animal feed supplements, concentrates, or premixes or in animals intended for food use shall not be construed to relieve such additives from the provisions of sections 505 and

Product	Tolerance	Limitations or restrictions
6. NUTRIENTS AND/OR DIETARY SUPPLEMENTS (1- cod.)		
*Methionine		Animal feeds Do.
*Methionine hydroxy analog and its calcium salts		
Niacin		
Niacinamide		
D-Pantothenic alcohol		
*Phenylalanine (L- and DL-forms)		
*Potassium chloride		
*Potassium glycerophosphate		
*Potassium iodide	0.01 percent	In table salt as a source of dietary iodine.
*Proline (L- and DL-forms)		
Pyridoxine hydrochloride		
Riboflavin		
Fluorobioflavin-5-phosphate		
*Sarcosine (L- and DL-forms)		
Sodium pantothenate		
Sodium phosphate (mono-, di-, tri-basic)		
Sorbitol	7 percent	In foods for special dietary use.
Thiamine hydrochloride		
Thiamine mononitrate		
*Threonine (L- and DL-forms)		
Tocopherols		
α-Tocopherol acetate		
*Tryptophan (L- and DL-forms)		
*Tyrosine (L- and DL-forms)		
*Valine (L- and DL-forms)		
Vitamin A		
Vitamin A acetate		
Vitamin A palmitate		
Vitamin B ₁		
Vitamin B ₂		
Vitamin B ₆		
Vitamin D ₂		
*Zinc sulfate		
*Zinc gluconate		
*Zinc chloride		
*Zinc oxide		
*Zinc stearate (prepared from stearic acid free from cholesterina factor)		
(a) SEQUESTRANTS ²		
Calcium acetate		
Calcium chloride		
Calcium citrate		
Calcium diacetate		
Calcium gluconate		
Calcium hexametaphosphate		
Calcium phosphate, monobasic		
Calcium phytate		
Citric acid		
Dipotassium phosphate		
(Disodium phosphate	0.02 percent	
Isosorbide citrate		
Monosorbide citrate		
Potassium citrate		
Sodium acid phosphate		
Sodium citrate		
Sodium diacetate		
Sodium gluconate		
Sodium hexametaphosphate		
Sodium metabisphosphate		
Sodium phosphate (mono-, di-, tri-basic)		
Sodium potassium tartrate		
Sodium pyrophosphate		
Sodium pyrophosphate, tetra		
Sodium tartrate		
Sodium thiosulfate	0.1 percent	In salt.
Sodium trimetaphosphate		
Stearic acid	0.15 percent	

See footnotes at end of table.

Product	Tolerance	Limitations or restrictions
(7) STABILIZERS		
*Acacia (gum arabic)		
Agar-agar		
*Ammonium alginate		
*Calcium alginate		
Carob bean gum (locust bean gum)		
Chondrus extract (carrageenin)		
*Ghatti gum		
Guar gum		
*Potassium alginate		
*Sodium alginate		
*Sterculia gum (karaya gum)		
*Tragacanth (gum tragacanth)		
(8) MISCELLANEOUS AND/OR GENERAL PURPOSE FOOD ADDITIVES		
Acetic acid		Buffer and neutralizing agent.
*Adipic acid		
Aluminum ammonium sulfate		
Aluminum potassium sulfate		
Aluminum sodium sulfate		
Aluminum sulfate		
Ammonium bicarbonate		
Ammonium carbonate		
Ammonium hydroxide		
Ammonium phosphate (mono- and dibasic)		
*Ammonium sulfate		
*Beeswax (yellow wax)		
*Beeswax, bleached (white wax)		
*Bentonite		
Butane		
Caffeine	0.02 percent	In cola-type beverages.
Calcium carbonate		
Calcium chloride		
Calcium citrate		
Calcium gluconate		
Calcium hydroxide		
Calcium lactate		
Calcium oxide		
Calcium phosphate (mono-, di-, tribasic)		
Caramel		
Carbon dioxide		
Carnauba wax		
Citric acid		
*Dextran (of average molecular weight below 100,000)		
Ethyl formate	0.0015 percent	As fumigant for cashew nuts.
*Glutamic acid		Salt substitute.
*Glutamic acid hydrochloride		Do.
Glycerin		
Glycerol monostearate		
Helium		
*Hydrochloric acid		Buffer and neutralizing agent.
*Hydrogen peroxide		bleaching agent.
Lactic acid		
*Lecithin		
Magnesium carbonate		
Magnesium hydroxide		
Magnesium oxide		
Magnesium stearate		As migratory substance from packaging materials when used as stabilizer.
*Malic acid		
*Methylcellulose (U.S.P. methylcellulose, except that the methoxy content shall not be less than 27.5 percent and not more than 31.5 percent on a dry-weight basis)		
Monopotassium glutamate		
*Nitrogen		
*Nitrous oxide		
Papsin		Propellant for certain dairy and vegetable-fat toppings in pressurized containers.

See footnotes at end of table.

Product	Tolerance	Limitations or restrictions
(c) MISCELLANEOUS AND/OR GENERAL PURPOSE FOOD ADDITIVES—CON.		
Phosphoric acid.....		
Potassium acid tartrate.....		
Potassium bicarbonate.....		
Potassium carbonate.....		
Potassium citrate.....		
Potassium hydroxide.....		
*Potassium sulfate.....		
Propylene glycol.....		
*Erythritol (sorbitol).....		
*Silica aerogel (finely powdered micro-cellular silica foam having a minimum silica content of 89.5 percent).....		Component of anti-foaming agent.
Sodium acetate.....		
Sodium acid pyrophosphate.....		
Sodium aluminum phosphate.....		
Sodium bicarbonate.....		
Sodium carbonate.....		
Sodium citrate.....		
*Sodium carboxymethylcellulose (the sodium salt of carboxymethylcellulose not less than 89.5 percent on a dry-weight basis, with maximum substitution of 0.95 carboxymethyl groups per anhydroglucose unit, and with a minimum viscosity of 25 centipoises for 2 percent by weight aqueous solution at 25° C.).....		
*Sodium caseinate.....		
Sodium citrate.....		
Sodium hydroxide.....		
*Sodium pectinate.....		
Sodium phosphate (mono, di, tri-basic).....		
Sodium potassium tartrate.....		
Sodium sesquicarbonate.....		
Sodium tripolyphosphate.....		
Succinic acid.....		
Sulfuric acid.....		
Tartaric acid.....		
Tracesin (glyceryl triacetate).....		
Triethyl citrate.....	0.25 percent	Dried egg whites

* Substances added from February 2 and August 4, 1960, proposed lists.
 † Amino acids listed may be free, hydrochloride salt, hydrated, or anhydrous form, where applicable.
 ‡ For the purpose of this list, no attempt has been made to designate those sequestrants that may also function as chemical preservatives.

(e) Spices, seasonings, essential oils, oleoresins, and natural extractives that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

(1) SPICES AND OTHER NATURAL SEASONINGS AND FLAVORINGS (LEAVES, ROOTS, BARKS, BERRIES, ETC.)

Common name	Botanical name of plant source
Alfalfa herb and seed.....	Medicago sativa L.
Allspice.....	Pimenta officinalis Lindl.
Ambrette seed.....	Hibiscus abelmoschus L.
Angelica.....	Angelica archangelica L. or other spp. of Angelica.
Angelica root.....	Do.
Angelica seed.....	Do.
Angostura (cuscuta bark).....	Galipea officinalis Hancock.
Anise.....	Pimpinella anisum L.
Anise, star.....	Illicium verum Hook. f.
Balm (lemon balm).....	Melissa officinalis L.
Basil, bush.....	Ocimum minimum L.
Basil, sweet.....	Ocimum basilicum L.
Bay.....	Laurus nobilis L.
Calendula.....	Calendula officinalis L.
Camomile (chamomile), English or Roman.....	Anthemis nobilis L.

(1) SPICES AND OTHER NATURAL SEASONINGS AND FLAVORINGS (LEAVES, ROOTS, BARKS, BERRIES, ETC.)—Continued

Common name	Botanical name of plant source
Camomile (chamomile), German or Hungarian.....	Matricaria chamomilla L.
Capers.....	Capparis spinosa L.
Capsicum.....	Capsicum frutescens L. or Capsicum annuum L.
Caraway.....	Carum carvi L.
Caraway, black (black cumin).....	Nigella sativa L.
Cardamom (cardamon).....	Elettaria cardamomum Maton.
Cassia, Chinese.....	Cinnamomum cassia Blume.
Cassia, Padang or Batavia.....	Cinnamomum burmanni Blume.
Cassia, Saigon.....	Cinnamomum loureirii Nees.
Cayenne pepper.....	Capsicum frutescens L. or Capsicum annuum L.
Celery seed.....	Apium graveolens L.
Chervil.....	Anthriscus cerefolium (L.) Hoffm.
Chives.....	Allium schoenoprasum L.
Cinnamon, Ceylon.....	Cinnamomum zeylanicum Nees.
Cinnamon, Chinese.....	Cinnamomum cassia Blume.
Cinnamon, Saigon.....	Cinnamomum loureirii Nees.
Clary (clary sage).....	Salvia sclarea L.
Clover.....	Trifolium spp.
Cloves.....	Eugenia caryophyllata Thunb.
Coriander.....	Coriandrum sativum L.
Cumin (cummin).....	Cuminum cyminum L.
Cumin, black (black caraway).....	Nigella sativa L.
Dill.....	Anethum graveolens L.
Elder flowers.....	Sambucus canadensis L.
Fennel, common.....	Foeniculum vulgare Mill.
Fennel, sweet (finocchio, Florence fennel).....	Foeniculum vulgare Mill. var. dulce (DC.) Alex.
Fenugreek.....	Trigonella foenum-graecum L.
Galanga (galangal).....	Alpinia officinarum Hance.
Garlic.....	Allium sativum L.
Geranium.....	Pelargonium spp.
Ginger.....	Zingiber officinale Rosc.
Glycyrrhiza.....	Glycyrrhiza glabra L. and other spp. of Glycyrrhiza.
Grains of paradise.....	Amomum melegueta Rosc.
Horehound (hoarhound).....	Marrubium vulgare L.
Horseradish.....	Armoracia lappathifolia Gilib.
Hyssop.....	Hyssopus officinalis L.
Lavender.....	Lavandula officinalis Chaix.
Licorice.....	Glycyrrhiza glabra L. and other spp. of Glycyrrhiza.
Linden flowers.....	Tilia spp.
Mace.....	Myristica fragrans Houtt.
Marigold, pot.....	Calendula officinalis L.
Marjoram, pot.....	Majorana onites (L.) Benth.
Marjoram, sweet.....	Majorana hortensis Moench.
Mustard, black or brown.....	Brassica nigra (L.) Koch.
Mustard, brown.....	Brassica juncea (L.) Coss.
Mustard, white or yellow.....	Brassica hirta Moench.
Nutmeg.....	Myristica fragrans Houtt.
Oregano (oregano, Mexican oregano, Mexican sage, organ).....	Lippia spp.
Paprika.....	Capsicum annuum L.
Parley.....	Petroselinum crispum (Mill.) Mansf.
Pepper, black.....	Piper nigrum L.
Pepper, cayenne.....	Capsicum frutescens L. or Capsicum annuum L.
Pepper, red.....	Do.
Pepper, white.....	Piper nigrum L.

(1) SPICES AND OTHER NATURAL SEASONINGS AND FLAVORINGS (LEAVES, ROOTS, BARKS, BERRIES, ETC.)—Continued

Common name	Botanical name of plant source
Peppermint	<i>Mentha piperita</i> L.
Poppy seed	<i>Papaver somniferum</i> L.
Pot marigold	<i>Calendula officinalis</i> L.
Pot marjoram	<i>Majorana onites</i> (L.) Benth.
Rosemary	<i>Rosmarinus officinalis</i> L.
Rue	<i>Ruta graveolens</i> L.
Saffron	<i>Crocus sativus</i> L.
Sage	<i>Salvia officinalis</i> L.
Sage, Greek	<i>Salvia triloba</i> L.
Savory, summer	<i>Satureia hortensis</i> L. (Satureja).
Savory, winter	<i>Satureia montana</i> L. (Satureja).
Sesame	<i>Sesamum indicum</i> L.
Spearmint	<i>Mentha spicata</i> L.
Star anise	<i>Illicium verum</i> Hook. f.
Tarragon	<i>Artemisia dracunculus</i> L.
Thyme	<i>Thymus vulgaris</i> L.
Thyme, wild or creeping	<i>Thymus serpyllum</i> L.
Turneric	<i>Curcuma longa</i> L.
Vanilla	<i>Vanilla planifolia</i> Andr. or <i>Vanilla tahitensis</i> J. W. Moore
Zedoary	<i>Curcuma zedoaria</i> Rosc.

(2) ESSENTIAL OILS, OLEORESINS (SOLVENT-FREE), AND NATURAL EXTRACTIVES (INCLUDING DISTILLATES)

Common name	Botanical name of plant source
Alfalfa	<i>Medicago sativa</i> L.
Allspice	<i>Pimenta officinalis</i> Lindl.
Almond, bitter (free from prussic acid)	<i>Prunus amygdalus</i> Batsch, <i>Prunus armeniaca</i> L. or <i>Prunus persica</i> (L.) Batsch.
Ambrette (seed)	<i>Hibiscus moschatus</i> Moench.
Angelica root	<i>Angelica archangelica</i> L.
Angelica seed	Do.
Angelica stem	Do.
Angostura (cusparia bark)	<i>Galipea officinalis</i> Hancock.
Anise	<i>Pimpinella anisum</i> L.
Asafoetida	<i>Ferula assa-foetida</i> L. and related spp. of <i>Ferula</i> .
Balm (lemon balm)	<i>Melissa officinalis</i> L.
Balsam of Peru	<i>Myroxylon pereirae</i> Klotzsch.
Basil	<i>Ocimum basilicum</i> L.
Bay leaves	<i>Laurus nobilis</i> L.
Bay (myrcia oil)	<i>Pimenta racemosa</i> (Mill.) J. W. Moore.
Bergamot (bergamot orange)	<i>Citrus aurantium</i> L. subsp. <i>bergamia</i> Wright et Arn.
Bitter almond (free from prussic acid)	<i>Prunus amygdalus</i> Batsch, <i>Prunus armeniaca</i> L. or <i>Prunus persica</i> (L.) Batsch.
Bois de rose	<i>Aniba roseodora</i> Ducke.
Cacao	<i>Theobroma cacao</i> L.
Camomile (chamomile) flowers, Hungarian	<i>Matricaria chamomilla</i> L.
Camomile (chamomile) flowers, Roman or English	<i>Anthemis nobilis</i> L.
Cananga	<i>Cananga odorata</i> Hook. f. and Thoms.
Capsicum	<i>Capsicum frutescens</i> L. and <i>Capsicum annuum</i> L.
Caraway	<i>Carum carvi</i> L.
Cardamom seed (cardamon)	<i>Elettaria cardamomum</i> Maton.
Carob bean	<i>Ceratonia siliqua</i> L.
Carrot	<i>Daucus carota</i> L.
Cascarilla bark	<i>Croton eluteria</i> Benn.
Cassia bark, Chinese	<i>Cinnamomum cassia</i> Blume.
Cassia bark, Padang or Batavia	<i>Cinnamomum burmanni</i> Blume.

(2) ESSENTIAL OILS, OLEORESINS (SOLVENT-FREE), AND NATURAL EXTRACTIVES (INCLUDING DISTILLATES)—Continued

Common name	Botanical name of plant source
Cassia bark, Saigon	<i>Cinnamomum loureirii</i> Nees.
Celery seed	<i>Aplium graveolens</i> L.
Cherry, wild, bark	<i>Prunus serotina</i> Ehrh.
Chervil	<i>Anthriscus cerefolium</i> (L.) Hoffm.
Chicory	<i>Cichorium intybus</i> L.
Cinnamon bark, Ceylon	<i>Cinnamomum zeylanicum</i> Nees.
Cinnamon bark, Chinese	<i>Cinnamomum cassia</i> Blume.
Cinnamon bark, Saigon	<i>Cinnamomum loureirii</i> Nees.
Cinnamon leaf, Ceylon	<i>Cinnamomum zeylanicum</i> Nees.
Cinnamon leaf, Chinese	<i>Cinnamomum cassia</i> Blume.
Cinnamon leaf, Saigon	<i>Cinnamomum loureirii</i> Nees.
Citronella	<i>Cymbopogon nardus</i> Rendle.
Citrus peels	<i>Citrus</i> spp.
Clary (clary sage)	<i>Salvia sclarea</i> L.
Clove bud	<i>Eugenia caryophyllata</i> Thunb.
Clove leaf	Do.
Clove stem	Do.
Clover	<i>Trifolium</i> spp.
Coca (decocainized)	<i>Erythroxylum coca</i> Lam. and other spp. of <i>Erythroxylum</i> .
Coffee	<i>Coffea</i> spp.
Cola nut	<i>Cola acuminata</i> Schott and Endl., and other spp. of <i>Cola</i> .
Coriander	<i>Coriandrum sativum</i> L.
Corn silk	<i>Zea mays</i> L.
Cumin (cumin)	<i>Cuminum cyminum</i> L.
Curacao orange peel (orange, bitter peel)	<i>Citrus aurantium</i> L.
Cusparia bark	<i>Galipea officinalis</i> Hancock.
Dandelion	<i>Taraxacum officinale</i> Weber and T. laevigatum DC.
Dandelion root	Do.
Dill	<i>Anethum graveolens</i> L.
Dog grass (quackgrass, triticum)	<i>Agropyron repens</i> (L.) Beauv.
Elder flowers	<i>Sambucus canadensis</i> L. and <i>S. nigra</i> L.
Estragole (esdragol, esdragon, tarragon)	<i>Artemisia dracunculus</i> L.
Estragon (tarragon)	Do.
Fennel, sweet	<i>Foeniculum vulgare</i> Mill.
Fenugreek	<i>Trigonella foenum-graecum</i> L.
Galanga (galangal)	<i>Alpinia officinarum</i> Hance.
Garlic	<i>Allium sativum</i> L.
Geranium	<i>Pelargonium</i> spp.
Geranium, East Indian	<i>Cymbopogon martini</i> Stapf.
Geranium, rose	<i>Pelargonium graveolens</i> L'Her.
Ginger	<i>Zingiber officinale</i> Rosc.
Glycyrrhiza	<i>Glycyrrhiza glabra</i> L. and other spp. of <i>Glycyrrhiza</i> .
Glycyrrhizin, ammoniated	Do.
Grapefruit	<i>Citrus paradisi</i> Macf.
Guava	<i>Psidium</i> spp.
Hickory bark	<i>Carya</i> spp.
Horehound (hoarhound)	<i>Marrubium vulgare</i> L.
Hops	<i>Humulus lupulus</i> L.
Horsemint	<i>Monarda punctata</i> L.
Hyssop	<i>Hyssopus officinalis</i> L.
Immortelle	<i>Helichrysum angustifolium</i> DC.
Jasmine	<i>Jasminum officinale</i> L. and other spp. of <i>Jasminum</i> .
Juniper (berries)	<i>Juniperus communis</i> L.
Kola nut	<i>Cola acuminata</i> Schott and Endl., and other spp. of <i>Cola</i> .
Laurel berries	<i>Laurus nobilis</i> L.

(2) ESSENTIAL OILS, OLEORESINS (SOLVENT-FREE), AND NATURAL EXTRACTIVES (INCLUDING DISTILLATES)—Continued

Common name	Botanical name of plant source
Laurel leaves	Laurus spp.
Lavender	Lavandula officinalis Chaix.
Lavender, spike	Lavandula latifolia Vill.
Lavandin	Hybrids between Lavandula officinalis Chaix and Lavandula latifolia Vill.
Lemon	Citrus limon (L.) Burm. f.
Lemon balm (see balm)	
Lemon grass	Cymbopogon citratus DC. and Cymbopogon flexuosus Stapf.
Lemon peel	Citrus limon (L.) Burm. f.
Licorice	Glycyrrhiza glabra L. and other spp. of Glycyrrhiza.
Lime	Citrus aurantifolia Swingle.
Linden flowers	Tilia spp.
Locust bean	Ceratonia siliqua L.
Lupulin	Humulus lupulus L.
Mace	Myristica fragrans Houtt.
Malt (extract)	Hordeum vulgare L. or other grains.
Mandarin	Citrus reticulata Blanco.
Marjoram, sweet	Majorana hortensis Moench.
Maté	Ilex paraguariensis St. Hil.
Melissa (see balm)	
Menthol	Mentha spp.
Menthyl acetate	Do.
Molasses (extract)	Saccharum officinarum L.
Mustard	Brassica spp.
Narlingin	Citrus paradisi Macf.
Neroli, bigarade	Citrus aurantium L.
Nutmeg	Myristica fragrans Houtt.
Onion	Allium cepa L.
Orange, bitter, flowers	Citrus aurantium L.
Orange, bitter, peel	Do.
Orange leaf	Citrus sinensis (L.) Osbeck.
Orange, sweet	Do.
Orange, sweet, flowers	Do.
Orange, sweet, peel	Do.
Origanum	Origanum spp.
Palmarosa	Cymbopogon martini Stapf.
Paprika	Capsicum annuum L.
Parsley	Petroselinum crispum (Mill.) Mansf.
Pepper, black	Piper nigrum L.
Pepper, white	Do.
Peppermint	Mentha piperita L.
Peruvian balsam	Myroxylon perelrae Klotzsch.
Petitgrain	Citrus aurantium L.
Petitgrain lemon	Citrus limon (L.) Burm. f.
Petitgrain mandarin or tangerine	Citrus reticulata Blanco.
Pimenta	Pimenta officinalis Lindl.
Pimenta leaf	Pimenta officinalis Lindl.
Pipsissewa leaves	Chimaphila umbellata Nutt.
Pomegranate	Punica granatum L.
Prickly ash bark	Xanthoxylum (or Zanthoxylum) Americanum Mill. or Xanthoxylum clava-herculis L.
Rose absolute	Rosa alba L., Rosa centifolia L., Rosa damascena Mill., Rosa gallica L., and vars. of these spp.
Rose (otto of roses, attar of roses)	Do.
Rose buds	Do.
Rose flowers	Do.
Rose fruit (hips)	Do.
Rose geranium	Pelargonium graveolens L'Her.
Rose leaves	Rosa spp.

(2) ESSENTIAL OILS, OLEORESINS (SOLVENT-FREE), AND NATURAL EXTRACTIVES (INCLUDING DISTILLATES)—Continued

Common name	Botanical name of plant source
Rosemary	Rosmarinus officinalis L.
Rue	Ruta graveolens L.
Saffron	Crocus sativus L.
Sage	Salvia officinalis L.
Sage, Greek	Salvia triloba L.
Sage, Spanish	Salvia lavandulaefolia Vahl.
St. John's bread	Ceratonla siliqua L.
Savory, summer	Satureia hortensis L.
Savory, winter	Satureia montana L.
Schinus molle	Schinus molle L.
Sloe berries (blackthorn berries)	Prunus spinosa L.
Spearmint	Mentha spicata L.
Spike lavender	Lavandula latifolia Vill.
Tamarind	Tamarindus indica L.
Tangerine	Citrus reticulata Blanco.
Tannic acid	Nutgalls of Quercus infectoria Oliver and related spp. of Quercus. Also in many other plants.
Tarragon	Artemisia dracunculua L.
Tea	Thea sinensis L.
Thyme	Thymus vulgaris L. and Thymus zygis var. gracilis Boiss.
Thyme, white	Do.
Thyme, wild or creeping	Thymus serpyllum L.
Triticum (see dog grass)	
Tuberose	Pollanthes tuberosa L.
Turmeric	Curcuma longa L.
Vanilla	Vanilla planifolia Andr. or Vanilla tahitensis J. W. Moore.
Violet flowers	Viola odorata L.
Violet leaves	Do.
Violet leaves absolute	Do.
Wild cherry bark	Prunus serotina Ehrh.
Ylang-ylang	Cananga odorata Hook. f. and Thoms.
Zedoary bark	Curcuma zedoaria Rosc.

(3) NATURAL SUBSTANCES USED IN CONJUNCTION WITH SPICES AND OTHER NATURAL SEASONINGS AND FLAVORINGS

Common name	Botanical name of plant source
Algae, brown (kelp)	Laminaria spp. and Nereocystis spp.
Algae, red	Porphyra spp. and Rhodymenia palmata (L.) Grev.
Dulse	Rhodymenia palmata (L.)

(4) NATURAL EXTRACTIVES (SOLVENT-FREE) USED IN CONJUNCTION WITH SPICES, SEASONINGS, AND FLAVORINGS

Common name	Botanical name of plant source
Algae, brown	Laminaria spp. and Nereocystis spp.
Algae, red	Porphyra spp. and Rhodymenia palmata (L.) Grev.
Apricot kernel (persic oil)	Prunus armeniaca L.
Dulse	Rhodymenia palmata (L.) Grev.
Kelp (see algae, brown)	
Peach kernel (persic oil)	Prunus persica Sieb. et Zucc.
Peanut stearine	Arachis hypogaea L.
Persic oil (see apricot kernel and peach kernel)	
Quince seed	Cydonia oblonga Miller.

(5) MISCELLANEOUS

Common name	Derivation
Ambergris	Physeter macrocephalus L.
Castoreum	Castor fiber L. and C. canadensis Kuhl.
Civet (sibeth, sibet, zibetum)	Civet cats, Viverra civetta Schreber and Viverra zibetha Schreber.
Cognac oil, white and green	Ethyl oenanthat, so-called.
Musk (Tonquin musk)	Musk deer, Moschus moschiferus L.

(f) *Trace minerals added to animal feeds.*¹ These substances added to animal feeds as nutritional dietary supplements are generally recognized as safe when added at levels consistent with good feeding practice.

Element	Source compounds
Cobalt-----	Cobalt acetate. Cobalt carbonate. Cobalt chloride. Cobalt oxide. Cobalt sulfate.
Copper-----	Copper carbonate. Copper chloride. Copper gluconate. Copper hydroxide. Copper orthophosphate. Copper oxide. Copper pyrophosphate. Copper sulfate.
Iodine-----	Calcium iodate. Calcium iodobenzenate. Cuprous iodide. 3,5-Dihodosalicylic acid. Ethylenediamine dihydroiodide. Potassium iodate. Potassium iodide. Sodium iodate. Sodium iodide. Thymol iodide.
Iron-----	Iron ammonium citrate. Iron carbonate. Iron chloride. Iron gluconate. Iron oxide. Iron phosphate. Iron pyrophosphate. Iron sulfate. Reduced iron.
Manganese-----	Manganese acetate. Manganese carbonate. Manganese citrate (soluble). Manganese chloride. Manganese gluconate. Manganese orthophosphate. Manganese phosphate (dibasic). Manganese sulfate. Manganous oxide.
Zinc-----	Zinc acetate. Zinc carbonate. Zinc chloride. Zinc oxide. Zinc sulfate.

(g) Synthetic flavoring substances and adjuvants that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

¹ All substances listed may be in anhydrous or hydrated form.

Acetaldehyde (ethanal).
Acetoin (acetyl methylcarbinol).
Aconitic acid (equiabetic acid, citridic acid, achillic acid).
Anethole (parapropenyl anisole).
Benzaldehyde (benzoic aldehyde).
N-Butyric acid (butanoic acid).
d- or l-Carvone (carvol).
Cinnamaldehyde (cinnamic aldehyde).
Citral (2,6-dimethyloctadien-2,6-di-8, geranial, neral).
Decanal (N-decylaldehyde, capraldehyde, capric aldehyde, caprinaldehyde, aldehyde C-10).
Diacetyl (2,3-butanedione).
Ethyl acetate.
Ethyl butyrate.
3-Methyl-3-phenyl glycidic acid ethyl ester (ethyl-methyl-phenyl-glycidate, so-called strawberry aldehyde, C-16 aldehyde).
Ethyl vanillin.
Eugenol.
Geraniol (3,7-dimethyl-2,6 and 3,6-octadien-1-ol).
Geranyl acetate (geraniol acetate).
Glycerol (glyceryl) tributyrate (tributyryl, butyryl).
Limonene (d-, l-, and dl-).
Linalool (linalol, 3,7-dimethyl-1,6-octadien-3-ol).
Linalyl acetate (bergamol).
1-Malic acid.
Methyl anthranilate (methyl-2-aminobenzoate).
Piperonal (3,4-methylenedioxy-benzaldehyde, heliotropin).
Vanillin.

(h) Substances migrating to food from paper and paperboard products used in food packaging that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

Acetic acid.
Alum (double sulfate of aluminum and ammonium potassium, or sodium).
Aluminum hydroxide.
Aluminum oleate.
Aluminum palmitate.
Ammonium chloride.
Ammonium hydroxide.
Calcium chloride.
Calcium hydroxide (lime).
Calcium sulfate.
Casein.
Cellulose acetate.
Clay (kaolin).
Copper sulfate.
Cornstarch.
Corn sugar (sirup).
Dextrin.
Diatomaceous earth filler.
Ethyl cellulose.
Ethyl vanillin.
Ferric sulfate.
Ferrous sulfate.
Formic acid or sodium salt.

Glycerin.
Guar gum.
Invert sugar.
Iron, reduced.
Locust bean gum (carob bean gum).
Magnesium carbonate.
Magnesium chloride.
Magnesium hydroxide.
Magnesium sulfate.
Methyl and ethyl acrylate.
Mono- and diglycerides from glycerolysis of edible fats and oils.
Oleic acid.
Oxides of iron.
Potassium sorbate.
Propionic acid.
Propylene glycol.
Silicon dioxides.
Pulps from wood, straw, bagasse, or other natural sources.
Soup (sodium oleate, sodium palmitate).
Sodium aluminate.
Sodium carbonate.
Sodium chloride.
Sodium hexametaphosphate.
Sodium hydrosulfite.
Sodium hydroxide.
Sodium phosphoaluminate.
Sodium silicate.
Sodium sorbate.
Sodium sulfate.
Sodium thiosulfate (additive in salt).
Sodium tripolyphosphate.
Sorbitol.
Soy protein, isolated.
Sulfamic acid.
Sulfuric acid.
Starch, acid modified.
Starch, pregelatinized.
Starch, unmodified.
Sucrose.
Talc.
Urea.
Vanillin.
Zinc hydrosulfite.
Zinc sulfate.

(i) Substances migrating to food from cotton and cotton fabrics used in dry food packaging that are generally recognized as safe for their intended use, within the meaning of section 409 of the act, are as follows:

Acacia (gum arabic).
Acetic acid.
Beef tallow.
Calcium chloride.
Carboxymethylcellulose.
Coconut oil, refined.
Corn dextrin.
Cornstarch.
Fish oil (hydrogenated).
Gelatin.
Guar gum.
Hydrogen peroxide.
Japan wax.
Lard.

Lard oil.
Lecithin (vegetable).
Locust bean gum (carob bean gum).
Oleic acid.
Peanut oil.
Potato starch.
Sodium acetate.
Sodium bicarbonate.
Sodium carbonate.
Sodium chloride.
Sodium hydroxide.
Sodium sulfate.
Sodium silicate.
Sodium tripolyphosphate.
Sorbosc.
Soybean oil (hydrogenated).
Stearic acid.
Talc.
Tall oil.
Tallow (hydrogenated).
Tallow flakes.
Tapioca starch.
Tartaric acid.
Tetrasodium pyrophosphate.
Urea.
Wheat starch.
Zinc chloride.

(Secs. 201(s), 409, 701(a), 52 Stat. 1055, 72 Stat. 1784, 1785 et seq., as amended; 21 U.S.C. 321(s), 348, 371(a)) [30 F.R. 15845, Dec. 23, 1965, as amended at 33 F.R. 5619, Apr. 11, 1968; 34 F.R. 17064, Oct. 21, 1969; 35 F.R. 1043, Jan. 27, 1970]

§ 121.102 Adjuvants for pesticide chemicals.

Adjuvants, identified and used in accordance with 40 CFR 180.1001 (c) and (d), which are added to pesticide use dilutions by a grower or applicator prior to application to the raw agricultural commodity, are exempt from the requirement of tolerances under section 409 of the act.

(Sec. 409, 72 Stat. 1785; 21 U.S.C. 348)

Subpart C—Food Additives Permitted in Feed and Drinking Water of Animals or for the Treatment of Food-Producing Animals

AUTHORITY: The provisions of this Subpart C issued under sec. 409, 72 Stat. 1785; 21 U.S.C. 348, unless otherwise noted.

§ 121.200 Definitions and interpretations applicable to Subpart C.

(a) Regulations prescribing conditions under which additives may be safely used in animal feed, animal feed supplements, concentrates, or premixes or in animals intended for food use shall not be construed to relieve such additives from the provisions of sections 565 and

507 of the act, where applicable, and § 121.7 and § 121.9 of the food additive regulations.

(b) For the purposes of this Subpart C:

(1) A "complete feed" is an article intended to be administered as the sole ration to an animal.

(2) A "feed additive supplement" is an article for the diet of an animal which contains one or more food additives, and is intended to be:

(i) Further diluted and mixed to produce a complete feed; or

(ii) Fed undiluted as a supplement to other rations; or

(iii) Offered free choice with other parts of the ration separately available.

A "feed additive supplement" is safe for the animal and will not produce unsafe residues in the edible products from food-producing animals if fed according to directions.

(3) A "feed additive concentrate" is an article intended to be further diluted to produce a complete feed or a feed additive supplement and is not suitable for offering as a supplement or for offering free choice without dilution. It contains, among other things, one or more additives in amounts, in a suitable feed base, such that from 100 to 1,000 pounds of concentrate must be diluted to produce 1 ton of a complete feed. A "feed additive concentrate" is unsafe if fed free choice or as a supplement, because of danger to the health of the animal or because of the production of residues in the edible products from food-producing animals in excess of the safe levels established in this Part 121.

(4) A "feed additive premix" is an article that must be diluted for safe use in a feed additive concentrate, a feed additive supplement, or a complete feed. It contains, among other things, one or more additives in high concentration in a suitable feed base such that up to 100 pounds must be diluted to produce 1 ton of a complete feed. A "feed additive premix" contains additives at levels for which safety to the animal has not been demonstrated and/or which may result, when fed undiluted, in residues in the edible products from food-producing animals in excess of the safe levels established in this Part 121.

(5) In feeding chickens:

(i) "Broiler, fryer, and roaster chickens" are chickens raised for meat purposes only.

(ii) "Replacement chickens" are chickens being raised for the purpose of egg production.

(iii) "Laying chickens" are chickens producing eggs for food.

(iv) "Breeding chickens" are chickens producing eggs used for hatching.

(6) In feeding swine:

(i) "Prestarter ration" is a feed administered from the time the baby pigs begin to eat until they weigh approximately 12 pounds.

(ii) "Starter ration" is a complete feed administered to the animals as they grow in weight from approximately 10 pounds to 50 pounds.

(iii) "Grower ration" is a complete feed administered to the animals as they grow in weight from approximately 30 pounds to 125 pounds.

(iv) "Finisher ration" is a complete feed administered to the animals as they grow in weight from approximately 100 pounds to market weight.

(c) The statements listed in this paragraph may be used on labels, if desired, in addition to the "indications for use" required by the applicable section entries:

(1) Prevention and treatment of bacterial swine enteritis by use of chlortetracycline may bear one or more of the additional parenthetical disease entities such as: "(Salmonellosis or necrotic enteritis caused by *Salmonella choleraesuis* and vibronic dysentery)" immediately after the required words "bacterial swine enteritis".

(2) [Reserved]

[30 F.R. 15845, Dec. 23, 1965, as amended at 32 F.R. 6775, May 3, 1967]

§ 121.201 Ethoxyquin in certain dehydrated forage crops.

Ethoxyquin (1,2-dihydro-6-ethoxy-2,2,4-trimethylquinoline) may be safely used in the dehydrated forage crops listed in paragraph (a) of this section, when incorporated therein in accordance with the conditions prescribed in this section:

(a) It may be added to dehydrated forage prepared from:

Alfalfa	Medicago sativa.
Barley	Hordeum vulgare.

Clovers:

Alsike clover	Trifolium hybridum.
Crimson clover	Trifolium incarnatum.

Red clover	Trifolium pratense.
White clover (including Ladino)	Trifolium repens.

White sweetclover	Mellilotus alba.
Yellow sweetclover	Mellilotus officinalis.

Coastal Bermuda grass	Cynodon dactylon.
-----------------------	-------------------

Corn	Zea mays.
------	-----------

Fescue	Festuca sp.
--------	-------------

Oats	Avena sativa.
------	---------------

Orchardgrass	Dactylis glomerata.
--------------	---------------------

Reed canarygrass	Phalaris arundinacea.
------------------	-----------------------

Ryegrass (annual and perennial)	Elymus sp. and Lolium perenne.
---------------------------------	--------------------------------

Sorghums	Sorghum vulgare, vars, feterita, shal-lu, kaoliang, broom-corn.
----------	---

Sudan grass	Sorghum vulgare sudanense.
-------------	----------------------------

Wheat	Triticum aestivum.
-------	--------------------

or any mixture of such forage crops, for use only as an animal feed.

(b) Such additive is used only as a chemical preservative for the purpose of retarding oxidative destruction of naturally occurring carotenes and vitamin E in the forage crops.

(c) It is added to the dehydrated forage crops in an oil mixture containing only suitable animal or suitable vegetable oil, prior to grinding and mixing.

(d) The maximum quantity of the additive permitted to be used and to remain in or on the dehydrated forage crop shall not exceed 150 parts per million.

(e) To assure the safe use of the additive, the label of the market package shall contain, in addition to other information required by the act:

(1) The name of the additive as specified in this section.

(2) Directions for the incorporation of the additive in the forage crops, as specified in paragraph (c) of this section, with the directive that only suitable animal or suitable vegetable oils are to be used in the oil mix.

(f) The label of any dehydrated forage crops treated with the additive or the label of an animal-feed supplement containing such treated forage crops, shall, in addition to other information required by the act, bear the following statements:

(1) "Ethoxyquin, a preservative," or "Ethoxyquin added to retard the oxidative destruction of carotene and vitamin E."

(2) The statement "For use in animal feed only."

§ 121.202 Ethoxyquin in animal feeds.

Ethoxyquin (1,2-dihydro-6-ethoxy-2,2,4-trimethylquinoline) may be safely used in animal feeds, when incorporated therein in accordance with the following prescribed conditions:

(a) It is intended for use only: (1) As a chemical preservative for retarding oxidation of carotene, xanthophylls, and vitamins A and E in animal feed and fish food and, (2) as an aid in preventing the development of organic peroxides in canned pet food.

(b) The maximum quantity of the additive permitted to be used and to remain in or on the treated article shall not exceed 150 parts per million.

(c) To assure safe use of the additive, the label and labeling of the food additive container and that of any intermediate premixes prepared therefrom shall contain, in addition to other information required by the act:

(1) The name of the additive, ethoxyquin.

(2) A statement of the concentration or strength contained therein.

(3) Adequate use directions to provide for a finished article with the proper concentration of the additive as provided in paragraph (b) of this section, whether or not intermediate premixes are to be used.

(d) The label of any animal feed containing the additive shall, in addition to the other information required by the act, bear the statement "Ethoxyquin, a preservative" or "Ethoxyquin added to retard the oxidative destruction of carotene, xanthophylls, and vitamins A and E."

§ 121.203 Polyoxyethylene glycol (400) mono- and dioleates.

The food additive polyoxyethylene glycol (400) mono- and dioleates may be safely used as an emulsifier in calf-milk replacer formulations.

§ 121.204 Dioxathion.

A tolerance of 18 parts per million is established for residues of dioxathion (2,3-p-dioxanodithiol-S,S-bis (O,O-diethylphosphorodithioate)) in dehydrated citrus pulp for cattle feed when present therein as a result of the application of the pesticide to the growing agricultural crop.

Handbuch der Drogenkunde, Erkennung, Wertbestimmung
und Anwendung, Band 1 (Untersuchungs methoden,
Cortices--Flores), pp. 318-319, 1949

Stigmata Maidis

By Franz Berger
Pharmacology Handbook, Identification, Evaluation
and Use, Vol. 1, Methods of Investigation,
Cortices--Flores
Vienna

Corn style or corn stigma, corn hair or beard, also called Styli maidis, are the filaments, about 25 cm long and 2.0-0.1 mm thick, of Zea mays L., a gramineous plant (grass) native to America and developed by cultivation in almost all countries of the world.

Prior to pollination, the filaments hanging out from the bracteole sheath at the tip of the cob are cut (Fig. 217) and quickly dried. These corn filaments (corn silk) have a light yellow to brownish color, are tasteless, and have a peculiar odor, similar to that of ergot when fresh. When examined under a magnifying glass, they appear as band-like, flat filaments with sunken broadsides and rounded narrow sides.

Detailed studies on the products found in these filaments were published by W. Freise (433), who investigated the so-called "Kentucky" variety, the composition of which does not differ greatly from that of other varieties.

Fresh corn filaments (corn silk) gave the following limit values for the most important components of therapeutic significance: fatty oil 1.85-2.55%, essential oil 0.08-0.12%, rubber-like products 2.65-3.80%, resin 2.25-2.78%, an alkaloid present in traces up to 0.05%, a glucosidic "bitter product" 0.80-1.15%, saponins 2.25-3.18%; in addition, the following were

found: 1.0-1.8% brown dye, 11.6-13.2% tannins, 3.55-4.15% reducing sugar, 4.85-5.25% mineral products, 11-15% moisture. The residue, which is of no therapeutic significance, consists mainly of cellulose.

According to Freise, the fatty oil has a yellow to gold color, a faint odor similar to that of crushed grass, a stale taste, and a density (15° C) of 0.9365; its refractive index (20° C) is 1.4558, its saponification number is 188 and iodine number 111, it solidifies at 11-12° in a tallow-like manner. Among its components, arachic and linoleic acids have been identified so far. When given internally in doses of 10-15 g, the oil acts as a mild purgative.

The essential oil is a greenish-yellow rather viscous liquid, with an odor remotely similar to that of *Ruta graveolens* oil and an initially burning and then irritating (scratchy) taste, a density (20°/4°) of 0.8635, a refractive index (n_D 20°) of 1.4825, and an optical rotation α_D 20°-22°35'; it is soluble in 6 vol. 90% alcohol; a component so far established with certainty is carvacrol (up to 18%).

The rubber-like components can be separated in the form of sharp-edged, lump-free, yellow-white chips (fragments) without any kind of granulation; they have a pungent odor, and form an opalescent slime with cold water; when boiled with dilute hydrochloric acid, these chips assume an orange color; they have no adhesive properties, their acid number is 11.8-22.7, their saponification number is 135-148, and they are insoluble in an ammoniacal copper oxide solution. Under the microscope, individual cell residues are visible. In a 1:100 H₂O solution, the rubber is more viscous than gum arabic, cherry gum or tragacanth. Under the action of acids, xylose is formed from the corn rubber; the strong diuretic effect of corn silk infusions can probably be attributed to xylose.

The alkaloid is found only in the stigma, is insoluble in water, but readily soluble in chloroform. This property can be used for manufacturing purposes. The alkaloid crystallizes from alcohol in needle clusters, which are volatilized without decomposition at 125-140° C. Inhalation causes psychic excitation, delirium, and tremors after prolonged use. Salivary flow, vomiting, colics, and watery diarrhea are observed as side-effects of its use. The glucosidic "bitter product" can be obtained in the form of a yellow-brown, amorphous powder, which can be split by dilute mineral acids into glucose and an indifferent, resin-like product. The saponins are a mixture of acid and neutral components; with a 0.01:100 decoction of corn silk, complete hemolysis can be achieved in a few minutes in a suspension of blood corpuscles in physiological saline solution. The alcoholic brown-yellow dye is therapeutically inactive (indifferent). The tannin colors an iron chloride solution green and yields pyrocatechol by fusion with caustic potash. The tannin content drops sharply during storage of corn silk. The reducing sugar is arabinose. The inorganic components include 34-42% potash, 13-18% soluble silicic acid and (mostly) several tenths percent manganese.

According to Peyer (440), corn silk is used in warmer countries in urinary disorders, and treatment of urinary gravel, in bladder diseases, especially bladder spasms. According to Freise (439), corn silk is an effective diuretic and a harmless, very effective weight-reducing and antiobesic agent. The diuretic action decreases (drops) rather quickly during storage of the product, namely when it has not been dried sufficiently, and gives way to a purgative action. According to Madaus (82), corn silk is considered valuable in cardiac dropsy, edemas with insufficient urination (micturition), and in diseases of the urinary tract with a tendency to sediment and stone

formation. In individual cases, corn silk is used in cystitis, pyelitis, and also in the treatment of gout, rhematism and gonorrhea.

Translated by
A. Schidlovsky (JITCO)
November 13, 1973

HANDBUCH DER DROGENKUNDE

ERKENNUNG, WERTBESTIMMUNG UND ANWENDUNG

VON

FRANZ BERGER^{*}
WIEN

EM. VORSTAND DER VEGETABIILIEN-ABTEILUNG DER CHEMOSAN-UNION A.-G.
FACHVORSTEHER DER DROGISTENSCHULE IN WIEN
UND MITGLIED DER DROGENSTANDARDISIERUNGSKOMMISSION

BAND 1

UNTERSUCHUNGSMETHODEN, CORTICES — FLORES

MIT 256 BILDERN, DAVON 162 ORIGINALE



1949

VERLAG WILHELM MAUDRICH / WIEN

zupften Blütenblätter ohne Staubgefäße und Griffel verwendet und sind nach dem Trocknungsprozesse von grauer, manchmal pergamentartig-durchscheinender Farbe.

Über die Inhaltsstoffe der Blüte ist nichts bekannt. Es existieren nur ältere Analysen der Lilienzwiebel, die Sterinoplasten mit Liliosterin in zwei Formen, Anthocyanin und Oxydase enthalten. Wieweit diese Substanzen auch in der Blüte vorhanden sind, bedarf erst der Klärung. H. Schulz²⁹⁷⁾ befürwortet eine klinische Überprüfung dieser Droge.

In der Volksmedizin wurden Lilienblüten mit Olivenöl angesetzt und das anschließend durch Verdampfen der Feuchtigkeit erhaltene Lilienöl als Hausmittel gegen Brandwunden, Geschwüre, Geschwülste, Karbunkel, Hautunreinigkeiten, Sommersprossen, Hitzblättern, ekzematöse Ausschläge, Quetschungen, Gicht, Rheumatismus, Hexenschuß, Insektenstiche, Verrenkungen, Zahngeschwüre, Wassersucht u. a. m. verwendet (Kneipp)⁴³⁸⁾.

STIGMATA MAIDIS.

Die Maisgriffel oder Maisnarben, Maishaare oder Maisbart, auch *Styli maidis* genannt, sind die etwa 25 cm langen und 0.2—0.1 mm dicken Griffel von *Zea mays* L., einer Graminee, welche in Amerika heimisch und durch Kultur in fast allen Staaten der Erde verbreitet ist.

Vor der Bestäubung werden die aus der Hochblattumhüllung an der Spitze der Kolben heraushängenden Griffel abgeschnitten (Abb. 217) und rasch getrocknet. Diese Maisgriffel sind von hellgelber bis bräunlicher Farbe, geschmacklos und besitzen einen eigenartigen, im frischen Zustande an Mutterkorn erinnernden Geruch. Unter der Lupe betrachtet sieht man, daß es sich um bandartige flache Fäden handelt mit eingesunkenen Breit- und abgerundeten Schmalseiten.

Eingehende Untersuchungen über die Inhaltsstoffe dieser Droge hat W. Freise⁴³⁹⁾ veröffentlicht. Freise untersuchte die sogenannte „Kentucky“-Spielart, von deren Zusammensetzung die sonstigen Spielarten nur sehr unwesentlich abweichen.

Frische Maisgriffel ergaben folgende Grenzwerte für die wichtigsten therapeutisch in Betracht kommenden Inhaltsstoffe: Fettes Öl 1.85—2.55%, ätherisches Öl 0.08—0.12%, gummiartige Stoffe 2.65—3.80%, Harz 2.25—2.78%, ein Alkaloid in Spuren bis zu 0.05%, ein glykosidischer „Bitterstoff“ mit 0.80—1.15%, Saponine 2.25—3.18%; außerdem wurden gefunden: 1.0—1.8% brauner Farbstoff, 11.6—13.2% Gerbstoffe, 3.55—4.15% reduzierender Zucker, 4.85—5.25% Mineralstoffe, 11—15% Feuchtigkeit; der therapeutisch nicht in Betracht kommende Rest besteht im wesentlichen aus Zellulose.

Das fette Öl ist nach Freise hell- bis goldgelb, von schwachem Geruch, etwa nach zerquetschtem Gras, von fadem Geschmack, vom spez. Gew. (15°) 0.9365; es hat den Brechungsindex (20°) 1.4558, Verseifungszahl 188, Jodzahl 111; es erstarrt bei 11—12° talgartig. Unter seinen Bestandteilen wurden bisher nachgewiesen Arachin- und Linolsäure. Innerlich verabreicht wirkt das Öl in Dosen von 10—15 g milde purgierend.

Das ätherische Öl präsentiert sich als eine grünlichgelbe, entfernt wie Öl von *Ruta graveolens* riechende, zuerst brennend, dann kratzend schmeckende, ziemlich viskose Flüssigkeit vom spez. Gew. ($20^{\circ}/4^{\circ}$) 0.8635, dem Brechungsindex ($n_D 20^{\circ}$) 1.4825, dem optischen Drehungsvermögen ($\alpha_D^{20^{\circ}} - 22^{\circ} 35'$); es ist löslich in 6 Vol. 90% Alkohol; ein bisher sicher nachgewiesener Bestandteil ist Carvacrol (bis zu 18%).

Die gummiartigen Inhaltsstoffe können in scharfkantigen, schollenlosen, gelblich-weißen Splintern ohne jegliche Körnung abgeschieden werden, welche leicht stechend riechen, im kalten Wasser einen opalisierenden Schleim geben, mit verdünnter Salzsäure gekocht orangefarben werden, keinerlei Klebkraft besitzen, die Säurezahl 11.8—22.7 und die Verseifungszahl 135—148 aufweisen, sowie in Kupferoxydammoniak unlöslich sind. Unter dem Mikroskop sind vereinzelte Zellreste sichtbar. In einer Lösung 1 : 100 in Wasser ist der Gummi viskoser als arabischer Gummi, Kirschgummi oder Traganth. Durch Säureeinwirkung entsteht aus dem Griffelgummi Xylose; dieser dürfte die energische diuretische Wirkung des Maisgriffelinfuses zuzuschreiben sein.

Das Alkaloid findet sich nur in den Narben; es ist in Wasser unlöslich, in Chloroform dagegen sehr leicht löslich. Diese Eigenschaft kann zur Herstellung benutzt werden. Aus Alkohol kristallisiert es in Büscheln von Nadeln, welche sich bei 125 bis 140° unzersetzt verflüchtigt. Die Inhalation verursacht psychische Erregung, Delirien, bei längerem Gebrauch Zuckungen. Speichelfluß, Erbrechen, Koliken, wässrige Durchfälle werden als Nebenerscheinungen seines Genusses beobachtet. Der glykosidische „Bitterstoff“ ist erhältlich in Gestalt eines gelbbraunen, amorphen Pulvers, welches durch verdünnte Mineralsäuren in Glykose und einen indifferenten, harzähnlichen Körper gespalten werden kann. Die Saponine stellen ein Gemenge saurer und neutraler Glieder dar; mit einer Abkochung von 0.01 : 100 der Griffel erzielt man in einer Aufschwemmung von Blutkörperchen in physiologischer Kochsalzlösung in wenigen Minuten Totallähmung. Der alkoholische braungelbe Farbstoff ist therapeutisch indifferent. Der Gerbstoff grünt Eisenchloridlösung und liefert in der Kalischmelze Brenzkatechin. Beim Lagern der Droge geht der Gehalt weit zurück. Der reduzierende Zucker ist Arabinose. In den anorganischen Bestandteilen finden sich 34—42% Kali, 13—18% lösliche Kieselsäure und (meistens) einige Zehntel Prozent Mangan.

Maisgriffel werden nach Peyer⁴⁴⁰⁾ in den wärmeren Ländern gegen Harnbeschwerden und Gries, Blasenleiden, besonders Blasenkrampf verwendet. Nach Freise⁴³⁹⁾ ist die Droge ein beachtliches Diuretikum und ein unschädliches, sehr wirksames Abmagerungs- und Entfettungsmittel. Die diuretische Wirkung nimmt beim Lagern der Droge, namentlich bei nicht genügendem Trocknen ziemlich schnell ab und macht einer purgierenden Wirkung Platz. Nach Madus⁸²⁾ wird die Droge bei Herzwassersucht, Oedemen mit ungenügender Harnabsonderung und bei Erkrankungen der Harnorgane mit Neigung zu Sedimenten und Steinbildung geschätzt. Im einzelnen gibt man das Mittel, bei Cystitis, Pyelitis und Lithiasis sowie gegen Gicht, Rheumatismus und Gonorrhöe.

Christensen, H. E. (Ed.)

1973

Toxic Substances List, 1973 Edition

U. S. Dept. of Health, Education, and Welfare
Natl. Inst. for Occupational Safety and Health

Page 230

Committee on Specifications

1972

Food Chemicals Codex, 2nd Edition

Committee on Food Protection
National Academy of Sciences, National Research Council
Washington, D.C.

Pages 175-176

11

PHARMACOLOGICAL ACTION OF A CORN SILK
(STYGMATA MAGS)* INFUSION.
FIRST COMMUNICATION.

B. D. Dzhamaliev (From the Microbiology Section of the Academy of Sciences of the Kazakh SSR)

SOURCE: Izvestiya Akademii Nauk Kazakhskog SSR. Seriya fiziologii i meditsiny, No. 3, pp. 81-93, 1954.

Urolithiasis is a disease known to mankind since ancient times. In the opinion of many authors, this disease is most widespread in countries with a hot climate. In the USSR, urolithiasis is encountered most frequently in regions of Central Asia, the middle Volga Region, Armenia, Georgia and Western Siberia.

Up to the present time, the etiology of this disease has still not been finally determined, and different opinions have been expressed on this matter. Most investigators explain the origin (appearance) of urolithiasis as being due to changes in the salt composition of urine and a disruption of the protective functions of its colloids; this is expressed in a precipitation of a salt deposit, which later assumes the appearance of a stony formation.

Other explanations for the emergence of urolithiasis are also known; for example, some of the probable causes involve an excess of proteins in food (Gridnev), disturbances in nutrition and metabolism (S. P. Fedorov), avitaminoses (Ovchinnikov and Gasparyan), and also infection processes caused by staphylococci, streptococci, coliform bacteria and other bacteria.

*Editor's Note: The popular name "corn silk" is used by the author to designate the long hair-like stigma of the Indian corn (maize) flower.

large amount of fluid was found in the area of the femoral lymph sacs, both on the left and right side, the amount of fluid being larger on the left side. No changes were noted on the front wall of abdominal muscles, and a very weak hyperemia of the skin of the abdomen was noted. A small amount of free liquid was found in the abdominal lymph sac, and a large amount of transparent fluid in the abdominal cavity. The heart had stopped in diastole, and was filled with blood. Upon mechanical stimulation, the heart contracted weakly twice. The liver was small and had a grey-green color. The stomach and the mesentery were slightly hyperemic, more so than under normal conditions. No special changes were noted in the stomach, and the bladder was normal.

Frog no. 1, weighing 50 g; 6 ml of a 20% corn silk infusion was introduced into the abdominal lymph sac through the right femoral sac. Two hours later, the frog became more apathetic, but responded actively to external stimulation, and retained its coordination of movements. After 6 hours, no changes took place, and after 24 hours the frog looked alert. No edema of the eye lids was noted, and no pathological changes were found upon external examination. After 2 days, the weight of the frog increased to 60 g. A slight (insignificant) edema of the eye lids appeared, and apathy increased. The movements became passive, but the frog jumped upon external stimulation. The edema of the eye lids increased considerably, and on the 3rd day after the infusion was introduced the frog was found dead at 9 AM. External examination of the frog revealed a strong hyperemia of the skin in the abdominal region. A moderate amount of transparent fluid was found in the right femoral sac. The skin of the thigh on the inner side was more hyperemic on the left thigh. The muscles of the right thigh had a softer consistency than under normal conditions. A transparent fluid was found in the abdominal cavity. The heart atria were filled with blood, and the heart ventricle was slightly contracted. The stomach was empty and contained a small amount

In this case, according to some authors, changes occur in the physical-chemical state of the urine, resulting in the precipitation of a protein-salt deposit, which, by becoming more compact, assumes the appearance of a stone (Spasokukotskii, Gridnev, Gel'strom).

As was pointed out by R. M. Fronshtein and N. N. Elanskii, one of the causes of the formation of kidney stones may be a disease of the parathyroid glands, during which, as is known, a disruption of calcium metabolism takes place.

Studies performed by K. M. Bykov (and his pupils, such as Balakshina, Kokhanovich et al.) have established a connection between the cerebral cortex and kidney activity. K. M. Bykov has reached the conclusion that "the kidney is represented in the cerebral cortex". Tests performed by Kokhanovich have proved beyond doubt that the formation of an inhibition focus (seat) in the cerebral cortex can result in a sharp increase of the sugar content.

Some authors (Elanskii, Shmukler) point to phosphaturia (with and without formation of stones) as the most striking example of the leading role of the central nervous system in the development of urolithiasis. The further study of this disease will also no doubt help in clarifying the etiology of urolithiasis.

At present, the treatment of urolithiasis consists either in surgical intervention on the organs of the urinary system, aimed either at a removal of the stones or of the entire affected kidney, or in the use of conservative methods of treatment providing temporary relief to the patient.

In popular (folk) medicine, infusions of various herbs have been used for a long time in the treatment of urolithiasis, and a corn silk infusion has been used very frequently for this purpose.

11

Experimental studies of Soviet scientists have confirmed the therapeutic properties of corn silk preparations as a cholagog. The use of corn silk infusions increases the secretion of bile and reduces its solid residue, while lowering its viscosity, density and bilirubin content.

According to data obtained by R. K. Aliev, corn silk contains sugar, fatty and resinous substances, essential oils, chlorophyll, and also vitamins C and K. The presence of the latter, according to Aliev, explains the more rapid coagulability of blood in dogs upon intravenous injection of corn silk extracts.

For the treatment of diseases of urinary organs, a corn silk infusion was apparently used for the first time in 1885 at the Cracow city clinic of Prof. Kortsinskii, and gave quite positive results, as indicated by Bartashevich. This infusion, used for the treatment of kidney stones and subacute catarrh of the bladder and renal pelvis, not only increased the amount of excreted urine, but also reduced catarrhal symptoms in the pelvis, exerting a pain-relieving (analgesic) effect. Stuver (1887), during the course of 5 years, was frequently convinced in the ability of corn silk extracts to relieve pain in the kidneys and bladder. A. P. Tsulukidze (1937) states that, for combating infections of the urinary tract, he has used for 10 years, among other measures, a corn silk infusion as "an effective diuretic, which does not irritate the kidneys".

Except for the authors mentioned above, who used corn silk infusions to treat urinary tract diseases, and, in particular, urolithiasis, we have not found more detailed data on the effect of this agent in the literature known to us.

The scarce literature sources refer merely to the widespread use of corn silk in folk medicine, while detailed data on the

11

study of this empirically used agent, on its therapeutic effect, on indications and counterindications for its use are still not available. Urolithiasis is a rather widespread disease, and every means which will bring relief to patients suffering from this disease should be adopted in practice. Starting from this premise, we have checked the effect of a corn silk infusion on kidney stones of various composition taken from patients, and on pathogenic bacteria under invitro test conditions. The innocuous nature (lack of toxicity) of the preparation was checked in tests with various animals.

The corn silk infusion was prepared as follows: corn silk weighed samples of 3, 5, 10 and 20 g were placed into flasks into which 100 ml distilled water was poured, and the flasks, closed with cotton plugs were autoclaved for 30 minutes at a pressure of 0.5 atm.

The infusion prepared in this manner was passed through a paper filter and was poured into test tubes under sterile conditions; previously sterilized kidney stones of definite weight and different chemical composition, consisting of oxalates, phosphates, carbonates and urates were then placed into the test tubes.

Part of the test tubes were placed in a thermostat at a temperature of 37°C, while another batch was kept at the usual room temperature. The condition of the stones was observed during 20-50 days, whereby the corn silk infusion was replaced every 3-4 days.

In some cases, the kidney stones were placed into a mixture of human urine and corn silk infusion, but this did not affect the results of the tests.

11

As a result of these tests, either a gradual dissolution of the stones was observed (if they consisted of carbonates), or their destruction with the formation of sand (if they contained urates and phosphates). The corn silk infusion did not exert a noticeable effect on stones consisting of oxalates. It was found that the process of dissolution and destruction of kidney stones followed a more rapid and intense course at a temperature of 37°C than at normal temperature (Tables 1, 2, 3 and 4). Table 1 (see p. 84). Data of Test No. 1 on the Destruction of Kidney Stones Under the effect of a 3% Corn Silk Infusion (11 February 1949).

(Under "Test Results", from top to bottom:)

- a) Incomplete destruction, changes proceed slowly.
- b) Complete destruction, stone is transformed into fine sand.
- c) Incomplete destruction, stone is transformed into fine sand.
- d) Complete destruction, stone is transformed into fine sand.
- e) Volume of the stone is reduced, no precipitate.
- f) Complete dissolution, no precipitate, transparent infusion.

Remarks (at bottom of table). Test tube numbers are arbitrary. All test tubes no. 1 were used in the test at room temperature (16-18°C), and test tubes no. 2 were placed in a thermostat at a temperature of 36-37°C. The weight of the stones in all tables are given in milligrams.

Table 2 (see p. 85). Data of Test No. 2 on the Destruction of Kidney Stones Under the Effect of a 5% Corn Silk Infusion (17 March 1949).

- 1) Temperature during test: room temperature (10-16°C), thermostat temperature (36-37°C).
- 2) Original weight of stones on 17 March.

(Under "Test Results", from top to bottom:)

- a) Destruction, stone reduced to fine sand.
- b) Complete destruction, stone reduced to fine sand.
- c) Reduction of the stone volume, no precipitate.

- d) Great reduction of the volume, no precipitate.
- e) Reduction of the volume, sand in the precipitate.
- f) Extensive change of the volume, sand in the precipitate.

Table 3 (see p. 86). Data of Test No. 3 on the Destruction of Kidney Stones Under the Effect of a 10% Corn Silk Infusion (15 August 1949).

(Under "Test Results", from top to bottom:)

- a) The stone dissolved without leaving a precipitate. The dissolution was slow.
- b) Slow destruction.
- c) A precipitate in the form of sand was formed, the destruction was rapid.

Table 4 (see p. 87). Data of Test No. 4 on the Destruction of Kidney Stones Under the Effect of a 20% Corn Silk Infusion (17 October 1949).

(Under "Test Results", from top to bottom:)

- a) Partial destruction.
- b) Complete destruction, stone reduced to fine sand.
- c) Complete dissolution, no precipitate, transparent infusion.

Further, tests were carried out to determine the bacteriostatic and bactericidal effect of this infusion on the following pathogenic bacteria: Staphylococcus albus, Streptococcus, Bact. coli commune, Bact. dysenteriae Flexner, Bact. typhi abdominalis, Bact. dysenteriae shiga, Brucellus abortus bovis, Brucella suis, Bact. anthracis.

The results of these tests showed that corn silk infusions in concentrations of 3, 5, 10 and 20% do not exert a bacteriostatic or bactericidal effect on the above bacteria.

The toxicity of corn silk preparations was studied on frogs. This study showed that a great variety of phenomena are observed

11

during the general action of the infusion, depending upon the individual nature of the animal and the concentration and dose of the infusion. From 1 to 9 ml of a 10% and 20% corn silk infusion was injected subcutaneously into the abdominal lymph sac of the frogs.

Each dose was tested first on a single frog, and then on 3-4 frogs of approximately the same weight (45-50 g). Thus, in series 1 (10 frogs), the average weight of each frog was 45 g, in series 2 (18 frogs) - 50g, and in series 3 (8 frogs) the animals each weighed 50 g. (Tables 5, 6, 7, see p. 88).

The data listed in these tables show that those frogs which received 6 ml or more of a 20% corn silk infusion almost all died, while frogs which received the infusion in a lower concentration (10%) remained alive, inspite of the fact that the amount of injected 10% and 20% infusion was the same.

Control frogs which received the same amount (from 1 to 9 ml) of a 0.65% NaCl solution all remained alive.

Depending upon the concentration of the infusion, the behavior of the frogs was different. For example, after injection of a 10% infusion, the frogs felt better than those which received a 20% infusion.

One hour after injection of the infusion, the general condition of the frogs was checked. The coordination of movements in the frogs was preserved, except for those which received 7, 8 and 9 ml of the infusion. In these animals, a certain laxity of movements (apathy) was noted. The frogs reacted actively towards external stimuli. After 4-5 hours, all frogs felt well, except those which had received 7, 8 and 9 ml of the 20% infusion; in the latter, a gradual inhibition and apathy was noted, and on

stimulation they performed a coordinated jump, but after 8-10 hours these frogs lost their ability to coordinate movements and to perform jumps. Approximately 6-7 hours after injection of 7, 8 and 9 ml of the 20% infusion, the movements of the frogs became more and more lax, instead of jumping they only moved about slowly and, finally, they became completely still, their breathing stopped and their reflexes vanished.

We shall now report data from the record of the first series of tests; 7 ml of a 20% corn silk infusion was introduced into the abdominal lymph sac of a frog weighing 45 g. After 2 hours, apathy was noted in the frog, and after 5 hours, it moved about slowly and with difficulty upon external stimulation. On the next day, at 10 AM, the frog was already found dead, and its weight was 52 g. No special changes were noted on external examination.

When the femoral lymph sacs of the dead frog were opened, a considerable amount of a clear, transparent fluid was found on both sides. A large amount of slightly yellowish lymph fluid was also found in the abdominal lymph sac, and the same was noted in the abdominal cavity. The heart was diastolic, with greatly dilated atria. The heart ventricle did not respond to mechanical stimulation. The liver was reduced in size, had a grey-green color and a more compact consistency than under normal conditions. The stomach of the frog was hyperemic; no special changes were noted in the abdominal cavity, and the lungs were normal.

Frog no. 2, weighing 45 g. At 2 PM, 8 ml of a 20% corn silk infusion was introduced into its abdominal lymph sac, and 30 min. later the frog became more apathetic. At 4 PM, a slight edema of the eye lids was noted, and the frog showed a weak response to external stimuli; At 7 PM, the breathing became very intermittent, and the frog did not respond to external stimuli. At 8 PM, the frog was dead, and its weight was 60 g. After dissection, a

11

of mucus. The bladder was filled, and no special changes were noted in other organs.

I. I. Sivertsev has tested the toxicity of a corn silk infusion. The preparation used was a transparent reddish-brown liquid, and it was tested on frogs, guinea pigs, rabbits and dogs.

On 17 October, the following amounts of a 10% corn silk infusion were introduced into the abdominal lymph sac of 3 frogs, weighing 58, 65 and 61 g: the first frog received 5 ml, the second 6 ml, and the third 10 ml. On the next day, the frogs were very apathetic, edematous (swollen), with particularly swollen lower eyelids. On weighing, it was found that the frogs had gained a considerable amount of weight, and this weight gain was greater than the weight of the infusion introduced. Thus, frog no. 1 (which had received 5 ml of the infusion) gained 17 g in weight, frog no. 2 (which had received 6 ml) gained 19 g, and frog no. 3 (which had received 10 ml) gained 23 g. The frogs were kept in half-liter glass jars, containing a small amount of tap water, and their weight had apparently increased due to absorption of water through the skin, since they did not receive any other kind of liquid.

During the next few days, the frogs remained very apathetic, but their weight dropped steadily. One week after introduction of the infusion, the apathy of the frogs began to decrease, and their weight was almost back to the original weight on the 12th day after the infusion was introduced. All 3 frogs remained alive.

A further series of tests on the toxicity of the infusion was carried out with 5 guinea pigs, weighing from 360 to 435 g; one of these (No. 3) was a control and did not receive the infusion. A 20% corn silk infusion was injected subcutaneously into the right thigh region of the 4 other guinea pigs; no. 1 received

8 ml, no. 2 - 9 ml, no. 4 - 7 ml, and no. 5 - 10 ml. Three days after injection, no deviations from the norm in the behavior of the guinea pigs could be detected, and no infiltrate at the injection site was noted. However, the weight of 2 guinea pigs dropped slightly (by 10-20 g), and the weight of the control guinea pig also dropped at the same time; the weight of the other 2 guinea pigs, however, increased, but in an insignificant amount (by 15-25 g). Four days after the first introduction, the infusion was injected a second time into the same 4 guinea pigs, but into the left thigh region: no. 1 received 11.5 ml, no. 2 - 12.5 ml, no. 4 - 12.5 ml, and no. 5 - 12.5 ml.

On the next day after this second introduction, an infiltrate was noted at the injection site in 3 guinea pigs, but no infiltrate was observed in guinea pig no. 1. Three days after introduction of the infusion, in none of the guinea pigs could an infiltrate be observed at the injection site, where it had completely dissolved. No deviations from the norm whatsoever in the behavior of the guinea pigs could be noted after the second introduction of the infusion. The next day after injection of the infusion, the weight of the test guinea pigs dropped by 30-40 g (it increased by 5 g in the control), but in the following days their weight started to increase, and after 12 days, in guinea pigs no. 2 and 4, it even exceeded by 50 g the original weight (i.e. the weight prior to the first introduction of the infusion), while the weight of no. 1 and 5 and of the control returned to its original value. Further observations of the guinea pigs were stopped 12 days after the first introduction of the infusion.

Further, tests were carried out on 4 dogs: no. 1 weighed 10.05 kg, no. 2 - 15.6 kg, no. 3 - 8.15 kg, and no. 4 - 7.15 kg. Dog no. 1 received 21 ml of the corn silk infusion, and dog no. 2 received 15.6 ml. Two hours after introduction of the

11

infusion, dog no. 1 began to limp slightly on its left leg, but this symptom disappeared the next day. No other changes in the behavior of the dog could be noted. Five days after the first introduction, the same 2 dogs received a second subcutaneous injection of a 5% infusion into the right thigh region: dog no. 1 received 43 ml (4 ml/kg live weight) and dog no. 2 received 40 ml (2.6 ml/kg live weight). This time, no changes whatsoever in the behavior of the dogs could be noted. The weight of dog no. 1, 10 days after injection, increased by 700 g, and the weight of dog no. 2 decreased by 300 g.

In two other dogs, the corn silk infusion was introduced into the stomach through the mouth by means of a stomach probe. Dog no. 3 received 163 ml of a 10% infusion (20 ml/kg live weight), and dog no. 4 received 320 ml (150 ml of 10% infusion and 170 ml of a 5% infusion, equal to 44 ml/kg live weight). No disturbances in the behavior of the dogs were noted. Five hours after the first introduction, dog no. 3 received 504 ml of a 5% infusion (60 ml/kg weight), and dog no. 4 received 470 ml of a 5% infusion (65 ml/kg weight). Their behavior remained unchanged. Ten days after the first introduction of the infusion, the weight of dog no. 3 increased from 8.15 to 9 kg, and that of dog no. 4 from 7.15 to 7.2 kg.

The last series of tests was carried out on 5 rabbits by intravenous injection of a sterile 20% corn silk infusion. Rabbit no. 1 (weight 1.7 kg) received 9 ml of a 20% infusion, by injection into the ear vein, rabbit no. 2 (weight 1.64 kg) received 14 ml, rabbit no. 3 (weight 1.97 kg) - 10 ml, rabbit no. 4 (weight 1.75 kg) - 10 ml, and rabbit no. 5 (weight 1.61 kg) - 10 ml. Four days later, the weight of all rabbits decreased by 50 to 135 g, but no other changes were noted. Four days after the first introduction, the rabbits received a second intravenous injection of the infusion: rabbit no. 1 received 9.5 ml,

rabbit no. 2 - 7 ml, rabbit no. 3 received 3 ml intravenously and 10 ml subcutaneously (into the left thigh region), rabbit no. 4 received 5 ml intravenously and 4 ml subcutaneously, and rabbit 5 received 9 ml intravenously.

No changes whatsoever were noted in the behavior of the rabbits, which started to eat beets immediately after injection of the infusion. It should be noted only that 3 days after the second introduction (i.e. 7 days after the first injection) the weight of the rabbits dropped: in rabbit no. 1, it dropped from 1.71 kg to 1.55 kg, in rabbit no. 2 - from 1.64 kg to 1.43 kg, in rabbit no. 3 - from 1.97 kg to 1.77 kg, in rabbit no. 4 - from 1.75 kg to 1.475 kg, and in rabbit no. 5 from 1.61 kg to 1.545 kg, i.e. the weight loss occurred on a scale averaging from 65 to 275 g for each animal.

Thus, tests with 5-20% corn silk infusions in the above amounts showed that such infusions are practically non-toxic for guinea pigs (on subcutaneous injection), for dogs (on subcutaneous injection and peroral introduction into the stomach), and for rabbits (on intravenous injection).

The data thus obtained served as a basis for carrying out more extensive experiments aimed at studying the therapeutic properties of a corn silk infusion; the results of such studies will be published by us as material becomes available.

All the tests described above were performed in the pharmacology laboratory of the V. M. Molotov Kazakh Medical Institute under the direction of Prof. I. I. Sivertsev.

CONCLUSIONS

1. When kidney stones, obtained from patients during operations, were subjected to the effect of 3, 5, 10 and 20% corn silk infusions, a dissolution of stones consisting of carbonates was observed, and a destruction, with formation of sand, was observed in stones consisting of urates and oxalates. The corn silk infusion did not exert a dissolving and destructive effect on kidney stones consisting of oxalates.

2. Destruction and dissolution of kidney stones under the effect of corn silk infusions was more rapid at a definite temperature. A temperature of 37°C was particularly effective.

3. In our tests, a corn silk infusion did not exert any bacteriostatic and bactericidal effect on a number of pathogenic bacteria.

4. Corn silk infusions (5, 10, 20%) did not exert any toxic effect when injected subcutaneously into guinea pigs (in doses of 7-12 ml), or intravenously into rabbits (in doses of 3-10 ml), or subcutaneously (in doses of 40-45 ml) or perorally into the stomach of dogs (in doses of 163-320 ml), and also when introduced into the lymph sac of frogs (in doses from 5 ml on). Frogs died only when 6-9 ml of a 20% infusion was introduced.

SUMMARY

As is known, corn silk preparations are used as a cholagog in clinical practice. On the basis of our tests, a corn silk infusion can be recommended under clinical conditions also for the treatment of patients with urolithiasis. However, we do not recommend the use of infusions stronger than 3% by people suffering at the same time from urolithiasis and hypertonic disease,

and also by old people, since in our tests an intravenous injection of a 5% corn silk infusion raised the blood pressure of dogs.

BIBLIOGRAPHY

1. Aliev R. K. Data on the characteristics of the chemical composition and blood coagulating action of corn stigma, Baku, 1947 (in Russian).
2. Simonova V. I. Role in the etiology of urinary stones, Tashkent, 1947 (in Russian).
3. Stuver. From the current press, Vrach, no. 1, 1885, vol. VI, p. 12, #7. (in Russian)
4. Gebler K. Physical-chemical problems in surgery, 1935, (in Russian)
5. Zemlinskii S. E. Medicinal plants of the USSR, Moscow, 1949, (in Russian)
6. Mikhlin D. M. Regulation of blood coagulation and Vitamin K₃. Sovetskaya meditsina No. 5-6, Moscow, 1943 (in Russian).
7. Elanskii N. N. New paths in the etiology and therapy of nephrolithiasis, 1940 (in Russian).
8. Tsulukidze A. P. Ways for the prevention and treatment of Kidney stone diseases, Urologiya, vol. 14, no. 2, Biomedgiz, 1937 (in Russian).
9. Shumkler B. A. Phospaturia (urolithic diathesis), Leningrad, 1941. (in Russian).

Table of Contents

Summary

CHEMICAL INFORMATION

	Page
I. Nomenclature	1
II. Empirical Formula	1
III. Structural Formula	5
IV. Molecular Weight	5
V. Specifications	5
VI. Description	6
VII. Analytical Methods	7
VIII. Occurrence and Levels	7

BIOLOGICAL DATA

I. Acute Toxicity	9
Frogs	9
Dogs	9
II. Short-Term Studies	9
Guinea Pigs	9
Rabbits	11
Dogs	11
Rats-Corn Silk Fluidextract	11
III. Long-Term Studies	12
IV. Special Studies	12
Effect on Pathogenic Bacteria <u>in vitro</u>	12
Hemolytic Action <u>in vitro</u>	12
Effect on Kidney Stones <u>in vitro</u>	12

BIOCHEMICAL ASPECTS

I. Breakdown	15
II. Absorption-Distribution	15
III. Metabolism and Excretion	15
IV. Effects on Enzymes and Other Biochemical Parameters	15
Corn Silk Fluidextract	16
Corn Silk and Corn Silk Fluidextract	20
V. Drug Interaction	20
VI. Consumer Exposure	20

SUMMARY

Description:

Corn Silk (Zea) is composed of the fresh styles and stigmas of Zea Mays Linne, i.e., the so-called "silk" of the ear of Indian corn or maize (27).

Acute Toxicity:

The MLD of corn silk for frogs via the abdominal lymph sac is 24,000 mg/kg BW (11). For dogs, it is greater than 6574 mg/kg BW per os (11).

Carvacrol^o, a major flavor component of the essential oil of corn silk, has a Lethal Dose (LD) of 75 mg/kg BW for frogs subcutaneously (32). In rabbits and cats, the LD is 100 mg/kg BW orally (32,34).

Short-term

Studies:

Guinea pigs, rabbits, and dogs tolerated divided doses parenterally over a five-day period totaling as much as 11,320, 2561, and 618 mg/kg BW, respectively (11). Loss of weight was the only significant symptom noted (11). In the case of guinea pigs, the effect (30-40 grams loss) was transient (11). Rabbits were 65 to 275 grams below the starting weight at the end of an experimental period of eight days (11). One of two dogs lost 300 grams over a ten-day period; the other animal gained 700 grams (11).

Special Studies:

Corn silk (1:10,000) caused complete hemolysis of blood corpuscles in physiologic saline within a few minutes (06).

Kidney stones consisting of carbonates were gradually dissolved by corn silk infusion (aqueous) in concentrations of 3, 5, 10 and 20% in vitro (11). Stones containing phosphates and urates were disintegrated with the formation of "sand" (11). There was no noticeable effect on kidney stones consisting of oxalates (11).

Biochemistry:

Corn silk contains a water-soluble feeding stimulant for corn earworm larvae (25,33). In the field, the larvae actually feed in the silk mass for 8-10 days before reaching the kernel (25).

Corn silk extract injected into hypertensive rats in doses of 0.1 mg/kg BW for 4 consecutive days lowered blood pressure from 17-82% of pre-treatment values without any evidence of toxic effects. There was no significant effect on the blood pressure of normotensive rats (37). In dogs, on the other hand, intravenous injection of a 5% corn silk infusion (aqueous) caused an elevation of the blood pressure (11).

An unidentified alkaloid in corn silk is reported to cause psychic excitation, delirium, and tremors after prolonged use (06). Side effects are increased salivary flow, vomiting, colics, and watery diarrhea (06). Corn silk has been reported to have physiologic effects as a diuretic (06,11), a heart stimulant (06,27), a bile secretion stimulant (11), a blood coagulant (11), an anti-diabetic (19), an antiobesic (06) and a narcotic (19).

Corn silk and corn silk fluid extract have been used since the days of folk medicine for the treatment of a variety of human diseases such as heart disease accompanied by edema (06), disorders of the urinary tract (06,11), obesity (19), diabetes (19), kidney stones (11), gout (06), rheumatism (06), and gonorrhea (35). According to one authority, corn silk is probably of little value in treatment of dropsy of heart disease (27).

Consumer Exposure: Corn silk is a direct food additive employed as a flavoring ingredient in maple, nut, and root beer flavors (12). Foods in which it is used are baked goods, candy, ice cream and ices, and non-alcoholic beverages (12,15).

Estimated average daily intakes from all food categories range from 0.1 mg for infants to 3.83 mg for children and adults (13). Maximum estimated daily intakes vary from 0.17 mg to 7.31 mg for these age groups (13).

Foods in which corn silk is employed at the maximum use level are baked goods (26.4 ppm), beverages type I (21.6 ppm), and soft candy (16.7 ppm) (13).

The total 1970 poundage reported to FEMA and NAS (five reports) was 405 pounds (13).

CHEMICAL INFORMATION

I. Nomenclature

A. Common name:

Corn Silk (Zea)

Corn Silk Fluidextract

B. Chemical name: No information

C. Trade names and Synonyms:

Corn Silk (Zea): Stigmatis Maidis; Styli Maidis (Latin);
Stigmata Maidis (hom.); Maisgriffel,
Maisnarben (German); Stigmates de Mais
(French); Estigmas de Maiz (Spanish);
Estigmes de Milke (Port.) (19).

Corn Silk Fluid extract: No information

D. Chemical Abstracts Services Unique Registry Number:

Corn Silk (Zea): 977000795

Corn Silk Fluidextract: 977000784

II. Empirical formula

Corn Silk, like many other plant products, is composed of a variety of substances. Hoppe (19) gives the following information on the chemical composition.

Table 1. Chemical Composition of Corn Silk (Zea) (19).

<u>Substance</u>	<u>Amount (approx)</u>
Tannin	11.5-13.0% ^a
Resin	2.5%
Saponins, brown dye, flavones	2.25-3.00%
Fatty oil ^b	1.85-2.25%
Bitter product (glucoside)	1.0%
Essential oil (Carvacrol, 18%)	0.1-0.2%
Alkaloid (unidentified)	up to 0.05%

^a According to other data 3.55-4.15%

^b With arachic (arachidic) and linoleic acids, pentosans, pentoses.

According to Berger (06), the most important components of therapeutic significance in corn silk (fresh corn filaments) are given in Table 2.

Table 2. Chemical Components of Corn Silk (Zea) (06).

Fatty oil	1.85-2.55%
Essential oil	0.08-0.12%
Rubber-like products	2.65-3.80%
Resin	2.25-2.78%
An alkaloid	traces-0.05%
Glucosidic "bitter product"	0.80-1.15%
Saponins	2.25-3.18%
A brown dye	1.00-1.80%
Tannins	11.60-13.20%
Reducing sugar ^a	3.55-4.15%
Mineral products	4.85-5.25%
Moisture	11.00-15.00%
Cellulose	- - - -

^a "The reducing sugar is arabinose"

Tsukinaga (35) reported the following analytical results for corn silk.

Table 3. General Chemical Composition of Corn Silk (Zea) (35).

Constituent	Per 100 Parts of Air-Dried Sample	Per 100 Parts of Anhydrous Sample
Moisture	12.65	---
Crude fat	1.92	2.20
Crude protein	16.63	19.04
Soluble nitrogen-free compounds	45.50	52.09
Crude fiber	17.70	20.26
Crude ash	5.60	6.41
Total nitrogen	2.83	3.24
Protein nitrogen	2.25	2.58
Nonprotein nitrogen	0.58	0.66
Pentosan	15.60	17.86
Methylpentosan	Trace amount	Trace amount
Reducing sugars	1.90	2.17
Nonreducing sugars	Trace amount	Trace amount
Galactan	"	"
Total acids (in terms of sulfuric acid)	0.49	0.56

Table 4. Inorganic Components of Corn Silk (Zea) (35).

Constituents	Per 100 Parts of Air-Dried Sample	Per 100 Parts Of Dried Sample
Moisture	12.65	---
Ash	5.60	6.41
Hydrochloric acid soluble silicic acid (SiO_2)	0.15	0.17
Iron oxide and Al_2O_3	0.33	0.33
Lime (CaO)	00.61	0.70
MgO	0.56	0.64
Potassium (K_2O)	1.67	1.91
Soda (Na_2O)	0.16	0.18
Phosphoric acid (P_2O_5)	0.56	0.64
Sulfuric acid (SO_3)	0.03	0.03
Chlorine (Cl)	0.30	0.34

Rademaker and Fischer (29) determined the presence of maizenic acid (See Fig. 1), phlobaphene^a, and albuminoids in corn silk. The dried silk contained 2.25% maizenic acid (27). Dzhamalieva (11) reported the presence of vitamins C and K.

Known constituents of corn silk with chemical information are:

Carvacrol	C ₁₀ H ₁₄ O	(06,19,34)
Phytosterin	C ₂₇ H ₄₆ O	(35)
Arachidic acid	C ₂₀ H ₄₀ O ₂	(19,34)
Linoleic acid	C ₁₈ H ₃₂ O ₂	(19,34)
Glucose	C ₆ H ₁₂ O ₆	(34,35)
Arabinose	C ₅ H ₁₀ O ₅	(06,34)
Vitamin C	C ₆ H ₈ O ₆	(11,34)

Carvacrol is a pungent, spicy compound found in corn silk and several other plant oils and essences (See CHEMICAL INFORMATION, VI, VIII). The natural and synthetic products are employed as food flavoring agents (38).

NOTE: Data on carvacrol were included in several other sections of this monograph because of its importance as a major constituent of the essential oil of corn silk (approx. 18%) and the only component thus far established with certainty (06,19). Moreover, its solubility characteristics would result in its being highly concentrated in tinctures and certain refined flavoring essences (CHEMICAL INFORMATION, VI). It has been found to be quite toxic (See Acute Toxicity Table 5).

^a Reddish-brown coloring matter found in plant material, particularly various barks

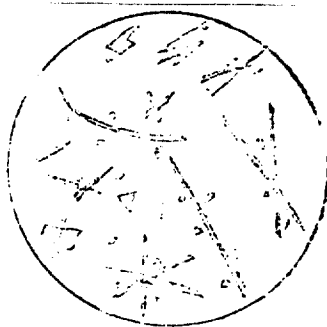


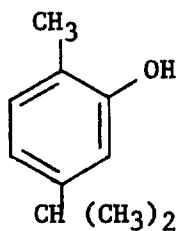
Figure 1. Maizenic Acid X700 (29)

III. Structural Formula

Corn Silk (Zea): No information

Corn Silk Fluidextract: No information

Carvacrol (34)



IV. Molecular Weight

Corn Silk (Zea): No information

Corn Silk Fluidextract: No information

Carvacrol: 150.24 (08)

V. Specifications

Corn Silk (Zea): No information

Corn Silk Fluidextract: No information

Carvacrol:

The Food Chemicals Codex, 2nd edition, 1972, gives the following specifications for carvacrol (09):

Assay. Not less than 98 percent, by volume, of phenols.

Refractive index. Between 1.521 and 1.526 at 20°.

Solubility in alcohol. Passes test.

Specific gravity. Between 0.974 and 0.979.

Limits of Impurities

Arsenic (as As). Not more than 3 parts per million (0.0003 percent).

Heavy metals (as Pb). Not more than 40 parts per million (0.004 percent).

Lead. Not more than 10 parts per million (0.001 percent). (Page 175)

VI. Description

A. Corn Silk (Zea)

"Corn silk or Zea consists of the fresh styles and stigmas of Zea Mays Linne" (27).

"Zea occurs as slender filaments from 10 to 20 cm. in length, and about 400 microns in diameter, purplish red through pink, reddish orange, brown, yellowish brown to greenish yellow. The stigmas are bifid, the segments being very slender, frequently unequal, and up to 3 mm in length" (27).

B. Corn Silk Fluidextract: No information

C. Carvacrol

Carvacrol is "a colorless to pale yellow liquid consisting mainly of a mixture of isomeric carvacrols (isopropyl o-cresols), and having a pungent, spicy odor resembling that of thymol" (09).

It is freely soluble in alcohol and in ether but practically insoluble in water (09,34). The physical constants are (34):

d_4^{20} : 0.976

bp : 237-238°C

mp : 0°C approx.

n_D^{20} : 1.52295

It is volatile with steam (34).

The Food Chemicals Codex states that carvacrol should be stored in full, tight, preferably glass, tin-lined or other suitably lined containers in a cool place protected from light (09).

VII. Analytical Methods

- A. Corn Silk (Zea): No information
- B. Corn Silk Fluidextract: No information
- C. Carvacrol:

The Food Chemicals Codex gives the following analytical methods for carvacrol (09).

Tests

Assay. Proceed as directed under Phenols, page 898

Refractive index, page 945. Determine with an Abbe or other refractometer of equal or greater accuracy.

Solubility in alcohol. Proceed as directed in the general method, page 899. One ml. dissolves in 4 ml. of 60 percent alcohol to form a clear solution.

Arsenic. A Sample Solution prepared as directed for organic compounds meets the requirements of the Arsenic Test, page 865.

Heavy metals. Prepare and test a 500-mg. sample as directed in Method II under the Heavy Metals Test, page 920, using 20 mcg. of lead ion (Pb) in the control (Solution A).

Lead. A Sample Solution prepared as directed for organic compounds meets the requirements of the Lead Limit Test, page 929, using 10 mcg. of lead ion (Pb) in the control. (Page 176)

VIII. Occurrence and Levels

A. Plants

Corn Silk (Zea): Corn Silk or Zea is the so-called "silk" of the ear of ordinary Indian corn or maize (27).

Corn Silk Fluidextract: Does not occur naturally. An extract of Zea.

Carvacrol: Carvacrol is found in oil of origanum, lovage oil, Dittany of Crete oil, oregano, thyme, marjoram, summer savory (12,34).

B. Animals: No information

C. Synthetics

Corn Silk (Zea): Pharmaceutical preparations.

Corn Silk Fluidextract: Pharmaceutical preparations..

Carvacrol: Carvacrol is used in food flavors (See BIOCHEMICAL ASPECTS,
Corn Silk, VI), as a disinfectant, and in organic syntheses (12,34,38).

D. Natural Inorganic Sources: No information.

Б. Д. ДЖАМАЛИЕВА

**О ФАРМАКОЛОГИЧЕСКОМ ДЕЙСТВИИ НАСТОЯ
ВОЛОСКОВ КУКУРУЗЫ (STYGMATA MAYS)***

Сообщение I

Из Сектора микробиологии Академии наук Казахской ССР

Мочекаменная болезнь известна человечеству со времен глубокой древности.

По мнению многих авторов это заболевание имеет наибольшее распространение в странах с жарким климатом. В СССР мочекаменная болезнь чаще встречается в районах Средней Азии, Средней Волги, Армении, Грузии и Западной Сибири.

Этиология данного заболевания до настоящего времени пока еще окончательно не установлена, и по этому вопросу существуют различные мнения. Большинство исследователей возникновения мочекаменной болезни объясняют нарушением коллоидального состояния мочи, приводящего к изменению солевого состава мочи, нарушению защитной функции ее коллоидов, что выражается в выпадении солевого осадка, который впоследствии приобретает вид каменного образования.

Есть и другие объяснения возникновения мочекаменной болезни, например, за счет избытка белковых веществ в пище (Гриднев), нарушения питания и обмена веществ (С. П. Федоров), авитаминозов (Овчинников и Гаспарьян), а также инфекционных процессов, вызываемых стафилококками, стрептококками, кишечной палочкой и другими бактериями. При этом наступает, по мнению авторов, ряд изменений физико-химического состояния мочи, что ведет к выпадению белково-солевого осадка, который, уплотняясь, приобретает вид камня (Спасокукоцкий, Гриднев, Гельстром).

Как указывают Р. М. Фронштейн и Н. П. Еланский, одной из причин образования камней почек может быть заболевание паразитовидных желез, при котором нарушается, как известно, кальцевый обмен.

Работами К. М. Быкова (и его учеников — Балакшиной, Кохановича и др.) установлена связь между корой головного мозга и деятельностью почек. К. М. Быков пришел к выводу, что «почка имеет представительство в коре мозга». Опыты Кохановича с несомненностью доказали, что при возникновении очага торможения в коре головного мозга в моче может резко увеличиться содержание сахара.

Некоторые авторы (Еланский, Шмуклер) указывают на фосфатурию (с образованием и без образования камней) как на наиболее яркий пример ведущей роли центральной нервной системы в развитии мочекаменной болезни.

* Под народным названием «волосок кукурузы» автор подразумевает длинное волосовидное рыльце кукурузного цветка (прим. ред.).